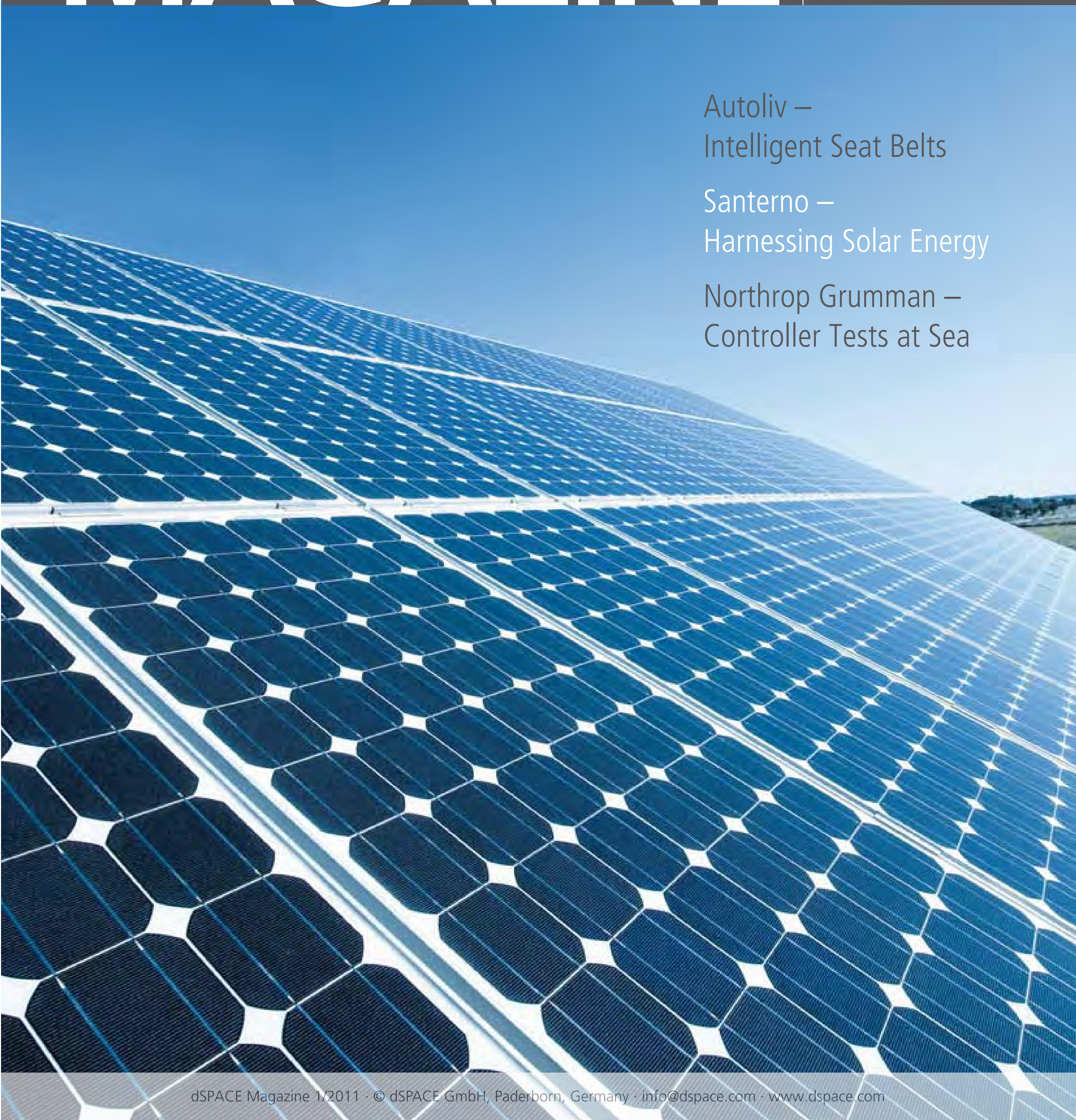
www.dspace.com

dSPACE MAGAZINE

1/2011



Autoliv – Intelligent Seat Belts

Santerno – Harnessing Solar Energy

Northrop Grumman – Controller Tests at Sea


dSPACE Simulator

Large companies who want to proclaim how innovative they are, often proudly quote what percentage of their turnover they spend on research and development. This might be 5% for very successful companies, or up to 10% for companies that see themselves as technology leaders.
I won't reveal the precise percentage that dSPACE spends on R&D, but I can say that it is definitely several times higher. Some may say dSPACE is at heart a research and development institute with integrated production and service departments. Indeed, we employ an enormous number of people who are completely dedicated to developing and further enhancing our product and service portfolio.

This explains how we can always take our developments one step further still, despite having reached a high technological level with so many components. The product articles in this magazine prove this once again. Even established and successful products should never stand still. Our customers' requirements certainly don't. And every now and then, even proven products and solutions need a radical rethink. That's how we created SCALEXIO, the new HIL simulator platform making its debut in the dSPACE Magazine on page 32.

The inspiration for SCALEXIO came to us many years ago. We were aware of the restrictions of the existing HIL technology, even though it still enjoys great market success. It was and obviously still is competitive, despite the fact that many of its architecture elements have not been changed for a very long time. After all, in our field, short-lived technology is definitely not what our customers need.
We have thought hard and long what SCALEXIO should be. Based on our experience with countless HIL projects, we have designed SCALEXIO to redefine the state-of-the art for HIL and we have invested a lot over many years to make it a reality. It raises scalability to a new level, from a small desktop simulator to an entire vehicle simulator, and does the same for I/O flexibility. The product name reflects both these characteristics. SCALEXIO is a completely brand-new development. Everything we have learned has gone into it. It gets our customers and us ready for the future. We know that this new system cannot cover all applications from the moment it is launched, as our proven HIL system can. This is why we provide options for coupling them, which guarantees our customers the investment protection that they rightly expect. The response to SCALEXIO proves that we are on the right track.

Dr. Herbert Hanselmann
CEO

Embedded Success dSPACE

IMPRINT

dSPACE MAGAZINE is published periodically by:

dSPACE GmbH · Rathenaustraße 26
33102 Paderborn · Germany
Tel.: +49 5251 1638-0
Fax: +49 5251 16198-0
dspace-magazine@dspace.com
www.dspace.com

Project Manager: André Klein
Responsible in terms of press law:
Bernd Schäfers-Maiwald

Authors: Ralf Lieberwirth, Sonja Lillwitz,
Julia Reinbach, Dr. Gerhard Reiß, Nina Riedel

Co-Workers on this issue: Dr. Ulrich Eisemann,
Dr. Andreas Himmler, Dr. Heiko Kalte, Susanne Köhl,
Holger Krisp, Andre Rolfsmeier, Holger Ross

Editors and Translators: Robert Bevington,
Stefanie Bock, Dr. Michelle Kloppenburg,
Christine Smith

Design: Krall & Partner, Düsseldorf, Germany
Layout: Sabine Stephan

Print: Media-Print Group GmbH, Paderborn

Contents

PEFC certified
The paper for this magazine is from sustainably managed forests and controlled sources.
PEFC
PEFC/04-31-0810
www.pefc.org

Power inverters:
Efficient energy transformation
through efficient TargetLink code

Upva

lue Energy

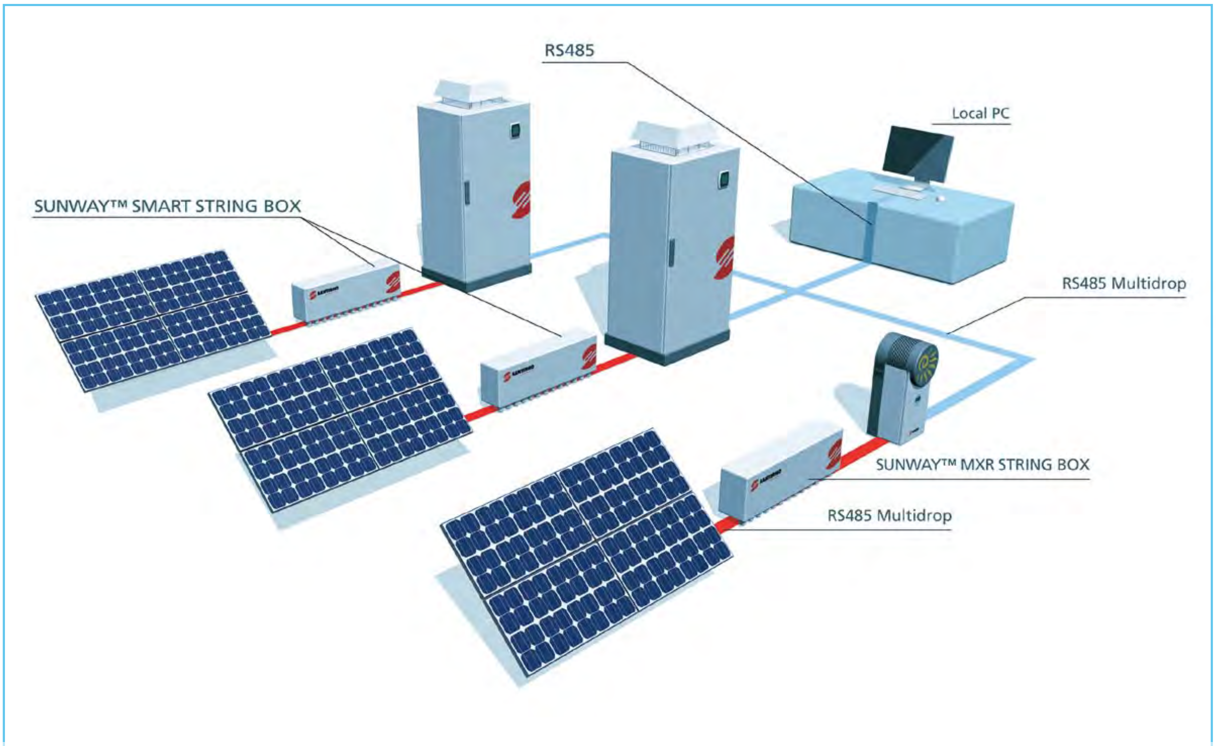
Every day, the amount of energy delivered by the sun is 15,000 times the current energy consumption worldwide. To exploit this natural energy source, solar energy has to be transformed into electrical energy. That's where Santerno's inverters are making a big impact.

Solar fields are made more efficient by intelligent controllers.

Inverters and Their Application Fields
Controlling industrial devices, solar fields, wind turbines and hybrid drives means controlling electric drives and handling high voltages and currents. A key part of the job is to convert direct current (DC) to alternating current (AC); this is done by a device called an inverter. A modern inverter can be described as a controller plus power stage electronics. For the application fields where Santerno's products are used (see below), controllers have to be able to handle various hard real-time requirements and complex tasks depending on the application.

- *Solar Fields*
  A photovoltaic (PV) field has to be controlled in terms of its optimal working point and efficient energy conversion. This is done by maximum power point tracking algorithms (MPPT) that find the best working point on the PV field, which varies throughout the day and in different weather conditions. The inverter DC link voltage has to be regulated to achieve efficient energy conversion, and the electrical current fed into the grid has to be regulated too. To meet certification standards, which also vary from country to country, several diagnostic and safety control functions have to be modeled to ensure a sufficient level of efficiency, total harmonic distortion (THD) and safety.

Setup of a solar field with inverters and control station.



> "When we use TargetLink, our power inverter mass production starts on time and meets our high quality standards."
>
> *Fabio Gianstefani, Santerno*

- *Wind Turbines*
  Harnessing wind energy involves controlling the wind mill for optimal orientation, speed and safety conditions. The principles of DC link regulation and grid-injected current regulation are generally the same as for the solar applications.

- *Industrial Automation*
  The enormous dynamics, high precision and accurate synchronization of modern drives and motion controls all need to be controlled. A typical example is a three-phase AC motor control by field-oriented control algorithms (FOC), vector torque control algorithms (VTC), and voltage on frequency (V/f) algorithms.

Controller Software Structure for the Inverters

The software for the "inverter system" can be functionally divided into an application layer and the platform software, which consists of a hardware abstraction layer (HAL), drivers, and services. Since services such as communication, diagnostics and calibration management and the hard real-time constraints are more or less identical in all the products, the platform software is the same for all controllers. Each controller only needs to be configured individually regarding real-time configurations, HAL mappings and service configurations to take specifics of the individual product into account. The cross-platform characteristic ensures better modularity and a shorter time to market for newer products. The application layer controls a physical plant such as a PV plant, a wind turbine, or a vehicle system and is developed individually for each product. The application layer can be further divided into subsystems such as the inverter layer and the application control layer, and is developed with dSPACE TargetLink®.

Controller Software Development Process

The application layer is suited for model-based development.
The tool chain at Santerno is based on MATLAB®/Simulink®/Stateflow® for model-based design and TargetLink for design, automatic production code generation and module testing. This tool chain is used in two different ways:

- Refinements of existing controllers are often developed with TargetLink, which is used to generate code for the additional functionality that is afterwards integrated with the controller's legacy code. These implementations are in floating-point arithmetic.
- New controller developments are carried out exclusively using the model-based approach with automatic production code generation. This means that the complete application layer is generated automatically with TargetLink. The size of the control software is typically about 15,000-20,000 lines of code. The most recent projects are developed in fixed-point arithmetic.

Challenges for Controller Development

On the whole, there were two major challenges that had to be mastered for controller development. The first was optimization: because the controller software runs on a task synchronized with the bridge PWM carrier, for example 11 kHz, its periodicity is lower than 100 microseconds. These imposed execution time requirements could be handled due to TargetLink's code efficiency in combination with using

In Brief

The exploitation of natural energy sources requires efficient electrical devices. Part of the job is using inverters to convert direct current (DC) to alternating current (AC). Santerno's inverters are equipped with controllers that ensure the greatest possible efficiency. Santerno has set up a development process that uses model-based design and automatic code generation for all controllers in the solar and wind energy application fields as well as in industrial automation. The experience from many production projects is that the benefits of using the dSPACE TargetLink code generator helped the company to meet its high time-to-market and quality objectives. The development department therefore aims to extend this approach to all new product developments.

The SUNWAY™ TG 600V and the SUNWAY M are examples of the inverter product line-up, equipped with control software generated by TargetLink.

modeling guidelines to optimize the CPU usage that runs at 72 Mhz. The second challenge was the scaling technique: because the production code has to control different power electronic sizes, where the maximum currents and voltages may vary a lot, a worst-case scaling approach was not affordable, so all the electrical current and voltage magnitudes had to be normalized to the range of [-1…1] by means of division by the sensor/actuator maximum.

Experience Gained

Model-based design and automatic production code generation have proven to be a reliable and convincing method for developing control software. In particular, the testing, traceability and documentation in TargetLink's development approach have turned out to be indispensable benefits for an efficient development process as they are decisive for high productivity and good quality:

- *Quick Back-to-Back Testing*
  Executing the automatically generated code on the host PC in a software-in-the-loop test allows fewer and faster iterations and ensures high quality code once it is integrated on the real target for the first time. Software-in-the-loop simulations also help greatly in properly scaling floating-point models for fixed-point implementations. The goal in the future will be to further increase the test coverage before the real integration of the product.

- *Proper Traceability*
  Teamwork in development benefits from easy-to-understand models, which are basically a part of the specification, and good code readability, which is important during code reviews. The complete traceability between the model and the C code turned out to be especially useful for improving code maintenance.

- *Automatic Documentation*
  Another time saver is the automatically generated documentation in HTML or PDF formats. The model serves as an executable specification and the automatically generated

The solar field at Fuente Alamo, Spain, delivers up to 26 MW energy using inverters from Santerno.

documentation of model and code can be extracted and integrated in specification and design documents as part of the documentation process.

Conclusions and Outlook

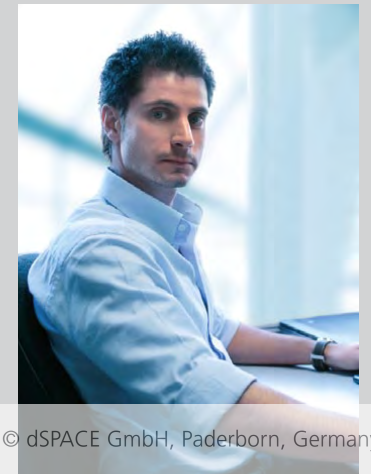
Many production projects have already been successfully completed at Santerno. During all of them, the time-to-market, performance and high quality objectives of the company were met. The goal of the development department is therefore to extend the model-based approach to all new product developments. In brief, the goal is to have more and more software automatically generated and meeting the stringent efficiency and quality requirements for Santerno's products. Improving the development process based on the selected tools is one of the constant challenges. One of the reasons to choose TargetLink is that certification of the code for solar inverters (both the platform and the application layer) is likely to be needed in some countries in the future, for example according to the ANSI/UL1998 standard in the USA. Using a model-based approach with TargetLink will help meet those requirements. ■

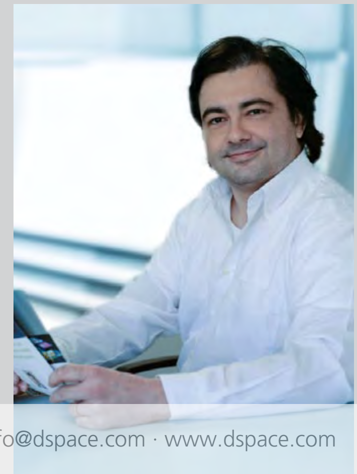
Riccardo Morici
Luca Balboni
Fabio Gianstefani, Santerno

Riccardo Morici
Mr. Morici is System Modeling & Control Design Manager for the three product families at Santerno in Imola, Italy.

Luca Balboni
Mr. Balboni is the Team Leader Model-Based Control Systems responsible for embedded application software and identification of test vectors at Santerno in Imola, Italy.

Fabio Gianstefani
Mr. Gianstefani is Software Architecture Leader responsible for embedded software specification and integration at Santerno in Imola, Italy.





Gentle Belts

Seat belts tightened the AUTOSAR way at Autoliv

In a crash, seat belts have to respond fast, without impacting too heavily on their wearers. The solution is to use pretensioners, which tighten the belts during the very first fractions of a second. Autoliv's active seat belt goes one step further by using a gentle pre-pretensioner that optimally softens belt impact. Its controllers use AUTOSAR-compliant software.

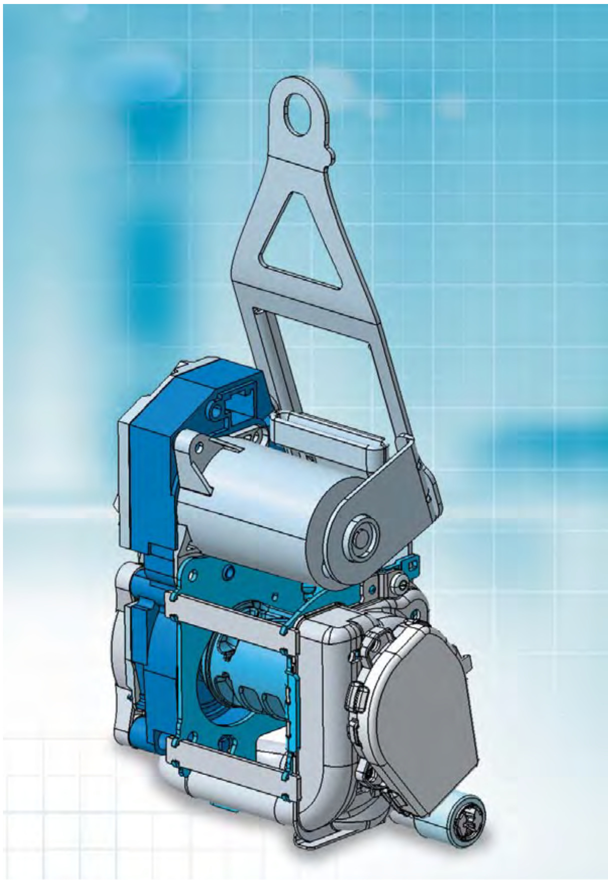
Seat Belt Pre-Crash Systems

At its location in Cergy near Paris, automotive supplier Autoliv is developing an electric seat belt pre-pretensioning system for production use by two different automobile manufacturers. This mechatronics system consists of a seat-belt retractor, an ECU and an electric motor (figure 1). As soon as emergency conditions are detected that are a potential pre-crash situation, such as panic braking or the vehicle being oversteered or understeered, the seat belt is electrically tightened to restrain its wearer before the accident. Then if an accident actually does occur, each vehicle occupant is ideally positioned in his or her seat, and the entire passive safety system, comprising pyrotechnical seat-belts and airbags, can deliver the best protection. If there is no accident, the belt is simply released. Not only does the device help reduce injuries in the event of an accident, it also delivers a warning to a driver who gets too close to safe driving limits, thereby acting as an active prevention device.
Additionally, the pre-pretensioner's comfort functions make the seat belt easy to put on and release, and dynamically adjust its tension to different driving situations.
The ECU processes data on the environment and on vehicle dynamics received from other ECUs via the vehicle's CAN bus, and provides control output to the electric motor for belt tensioning. The hardware platform for the ECU is a 32-bit microcontroller.

OEM-Specific Processes

The requirements for the ECU under development can be categorized as either functional or system-specific. The functional requirements for the application, in this case the belt tensioning logic, are implemented by Autoliv. They can take different forms: textual specifications, models, or initial software component descriptions in the ECU extract (see textbox

Figure1: Autoliv's seat belt pre-pretensioner holds the wearer in a better position before an accident occurs.



The AUTOSAR Workflow

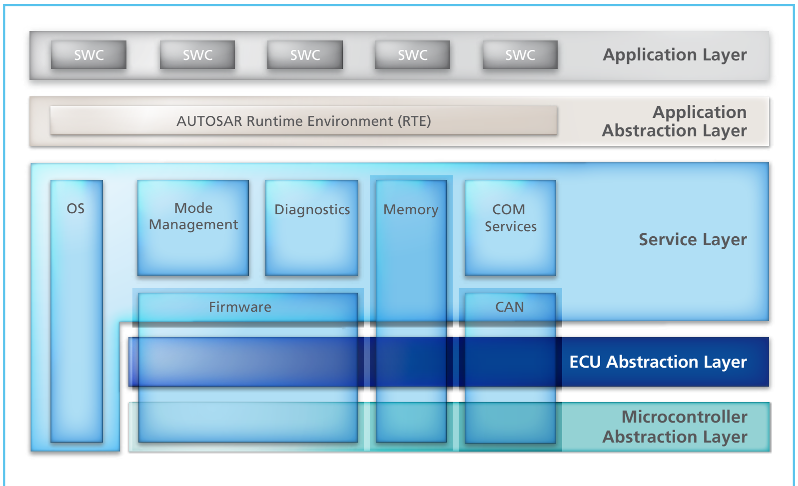
The Automotive Open System Architecture, or "AUTOSAR" for short, is a standard created by car manufacturers, ECU suppliers and tool providers to meet the increased requirements on the functionality and quality of in-vehicle software, while at the same time shortening development times. The standard AUTOSAR workflow begins with the OEM defining the system parameters, which comprise the network topology and ECU communication (messages, signals) as well as the distribution of application software to different ECUs in the network. The resulting system description is made available to the ECU manufacturers either as an AUTOSAR System Description file or as an "ECU extract from System Description" which contains only the data that are relevant for the specific ECU.
The OEM can specify the software architecture in advance with different granularities, after which the supplier develops single software components for it. Implementations with the desired behaviors are then produced for the individual software components, either by reusing existing software components or by developing new functionalities. For new developments, a model-based process can be used.
The descriptions of the software components provide a frame for developing a MATLAB®/Simulink® model from which the AUTOSAR-compliant production code is generated. The supplier configures the AUTOSAR basic software modules in accordance with the contracted AUTOSAR system description and also generates the code for these modules, which together with the code for the applications makes up the overall ECU software (figure 2).

The AUTOSAR Workflow). To ensure smooth interaction with other ECUs installed in the vehicle, the OEM provides the system-specific requirements, for example, for ECU communication via the in-vehicle bus system (in this case, CAN). Depending on the OEM that Autoliv is working for, these requirements are also provided in the ECU extract obtained from the AUTOSAR system description, or they can take the form of a communication matrix (in this case, a DBC file describing the CAN communication).

Modeling the ECU Application with SystemDesk and TargetLink

The model-based development of application software and correct configuration of AUTOSAR basic software, and the integration of all the software on the target platform, are essential steps in the AUTOSAR development process.
For the pre-pretensioner controller development, these tasks are being carried out by a combination of tools: the architecture software SystemDesk® and the code generator TargetLink® from dSPACE, and the configuration editor EB tresos® Studio from Elektrobit (EB).
To develop the AUTOSAR software of the ECUs, Autoliv introduced the design flow depicted in Figure 3. Working in SystemDesk, the software architect imports the requirements from the ECU extract as a starting point for creating a detailed software architecture. The descriptions of the AUTOSAR services are also read in as further building blocks. Autoliv utilizes all the available design options for the software architecture to maximize reusability across different projects. The descriptions of the individual software components are then passed to the function developers in AUTOSAR format.
The function developers import the AUTOSAR descriptions into TargetLink, where they can generate a frame model with the predefined inputs and outputs. The frame model is then filled either by reusing existing submodels or by modeling from scratch. The well-established model-in-the-loop (MIL) and software-in-the-loop (SIL) simulation methods are used for testing and validation. Then the AUTOSAR-compliant production code is generated automatically by TargetLink. The entire function development process is distributed across several different Autoliv locations.

Figure 2: Layered structure of the AUTOSAR software architecture.



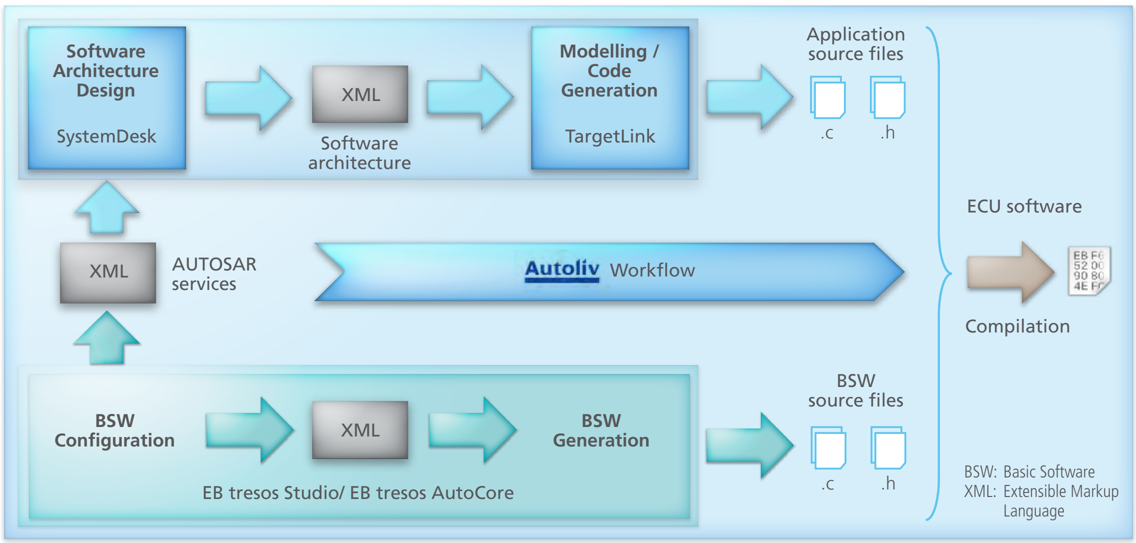
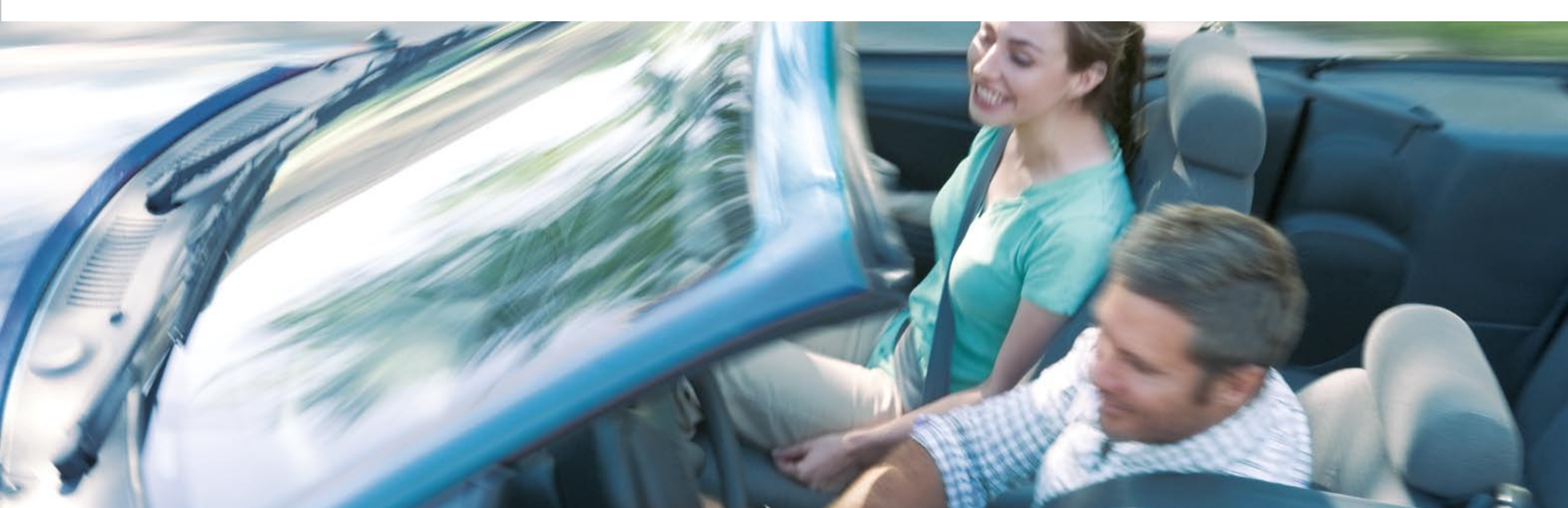


Figure 3: AUTOSAR design flow used at Autoliv.

Configuring the AUTOSAR Basic Software with EB tresos Studio

Autoliv's software integrator starts work in parallel to the application software development. The developer configures and generates the ECU's basic software with EB tresos Studio. Different OEMs specify the basic software to be used in different ways, using the EB tresos AutoCore as the basis. This contains the AUTOSAR modules, including the AUTOSAR run-time environment (RTE) and the hardware-specific microcontroller abstraction layer (MCAL). Different OEM-specific modules are added to the modules in the EB tresos AutoCore and integrated to create complete, OEM-specific basic software. One of AUTOSAR's main advantages comes into play here, enabling Autoliv to integrate the seat belt pre-pretensioner application into ECUs with different basic software implementations. It is essential that the software

> "Working with SystemDesk greatly improved software reusability across projects."
>
> *Claude Redon, Autoliv*



Strength in Unity

"Cooperate on standards, compete on implementation" is the philosophy behind the AUTOSAR consortium's standardization activities. Since 2006 cooperation is also a driving force for dSPACE and EB, both Premium Members in the consortium right from the beginning. Their joint efforts focus on their software tools, and on ensuring that they work together smoothly according to the AUTOSAR design methodology. dSPACE's contribution is its established software architecture and simulation tool SystemDesk and its production-proven code generator TargetLink, while Elektrobit provides production-ready AUTOSAR basic software with its products EB tresos AutoCore and EB tresos Studio. Together, these form a complete, well-coordinated tool chain covering AUTOSAR design methods from the software architecture description to model-based application development, to the configuration and generation of the electronic control unit's (ECU's) basic software on the target platform, thereby covering all the layers of the AUTOSAR standard software architecture as shown in figure 1. This extremely practical solution for ECU development benefits OEMs and their Tier 1 suppliers alike.

> "Early software verification was achieved by performing back-to-back tests with TargetLink."
>
> *Claude Redon, Autoliv*

components comply with the AUTOSAR standard (in this case, a mixture of AUTOSAR Release 3.0 and 3.1) and also with the interface specifications, so that they can be connected via the AUTOSAR run-time interface (RTE) with no problems.

From Architecture to Production Code

The AUTOSAR basic software is configured by reading the software architecture that was exported from SystemDesk, plus the ECU extract or the DBC file, into EB tresos Studio. This process results in a preconfigured RTE and preconfigured communication modules. To complete the RTE configuration, the data elements of the individual software components' ports are mapped to the signals in the bus communication (data-to-signal mapping), the runnables are assigned to operating system tasks (runnable-to-task mapping), and the service ports are connected to the appropriate ports on the software components (service port mapping).
Next, the integrator configures the parameters of the basic software modules in EB tresos Studio, partly using script automation. Then code is generated in EB tresos Studio to produce the complete source code for the AUTOSAR basic software. This is passed to the build environment together with the source code for the application components from TargetLink. The final result is the executable binary code, which is used to program the ECU. Figure 4 illustrates the resulting software layers and shows which tools are used for which steps.

Benefit from Cooperation

dSPACE's and EB's early and continued commitment to this demanding automobile industry standard is reflected in the tools that they supply. The tools combine perfectly to harness the two companies' core areas of expertise: the model-based development of application software and the creation of software run-time platforms for ECUs. The parts of the specification required for applying the AUTOSAR standard are mapped to the tools to make developers' work easier. The advantages of AUTOSAR for the reliable development of reusable software are combined with the model-based methods used to develop that software efficiently. The tools support the specification and generation of software, provide generators and automated steps, and help ensure seamless consistency and validation. The systematic use of standardized AUTOSAR descriptions ensures that the tools interact smoothly.
Wherever there are still specification gaps in the standard, the tool manufacturers consult to avoid incompatibilities. Pragmatic solutions are found and tested to prevent in advance any technical problems that might occur.
At Autoliv, the dSPACE and EB tresos products were supplemented by process consultation in introduction projects based on AUTOSAR. Experts from dSPACE and EB gave on-site support to ensure efficient tool use.

Project Experience

Autoliv is fully committed to the AUTOSAR standard in these projects. The initial investments for introducing AUTOSAR are already being off-

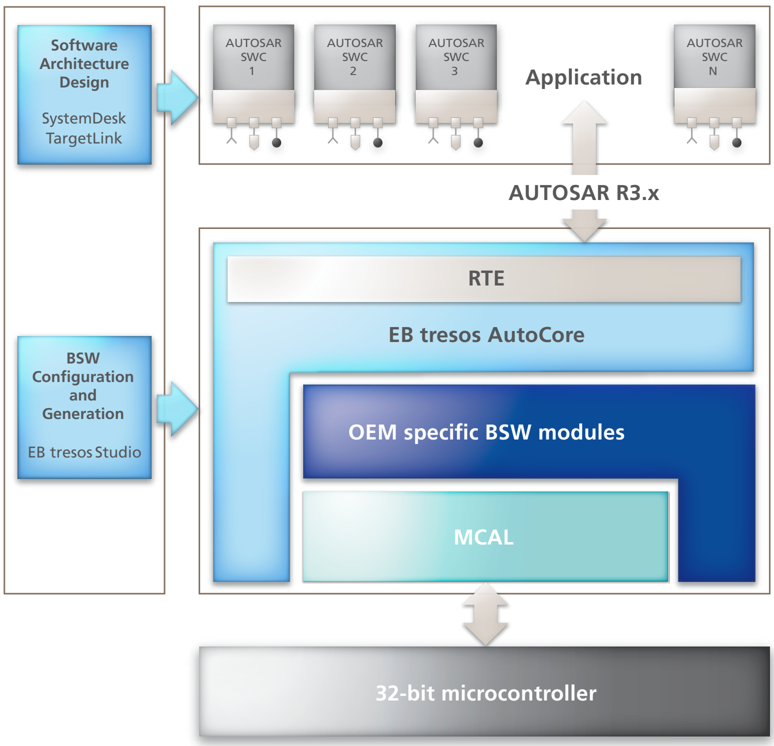


Figure 4: The structure of the final ECU software.

In Brief

For optimum safety, seat belt pre-pretensioners hold their wearers in a better position before an accident occurs. They also act as an active prevention device by delivering a warning to the driver who gets too close to safe driving limits. The controller for Autoliv's latest pre-pretensioner has been developed in compliance with the AUTOSAR standard. The design flow is based on the SystemDesk architecture software and the TargetLink code generator from dSPACE for developing the application layer. The basic software is configured with EB tresos Studio from Elektrobit. Easy software modularization and improved reuse of the application software are two of the benefits Autoliv experienced during development.

set by considerable improvements in software development. Two of the benefits are explicit software modularization and improved reuse of the application software. The systematic use of the standardized AUTOSAR exchange formats gives optimum support to all the individual process steps. The AUTOSAR methods are ideal for combining with model-based function development and automatic production code generation. The experience gathered and the results achieved in these projects show that the dSPACE and EB tools are a complete success in these very tool-supported developments. Continuous further development, based on new versions of the standard and on the requirements of ongoing projects, keeps the products up-to-date and guarantees proven tool interaction. ■

Peter Kirsch, Elektrobit
Claude Redon, Autoliv
Joachim Stroop, dSPACE

Pictured left to right are:

Claude Redon
Mr. Redon is a software architect with responsibility for the pre-pretensioner family at Autoliv in Cergy, France.

Joachim Stroop
Mr. Stroop is Lead Product Manager with responsibility for the SystemDesk tool at dSPACE GmbH in Paderborn, Germany.

Peter Kirsch
Mr. Kirsch is Product Manager with responsibility for the tool EB tresos Studio at Elektrobit Automotive GmbH, Erlangen, Germany.

Figure 1: Unlike classic aircraft carriers, large-deck assault ships like the Makin Island have no aircraft launch catapult. They serve as bases for helicopters, vertical-takeoff planes and landing craft.

The USS Makin Island is the first large-deck assault ship in the U.S. Navy to be powered by a combination of gas turbines and electric motors. The new propulsion system considerably reduces fuel consumption and maintence costs when compared with the steam turbine-based propulsion otherwise used in this class of ship, yet without compromising performance. To test the control software for the gas turbine propulsion system, manufacturer Northrop Grumman used a dSPACE system on board the ship itself.

Gas Turbine Saves Fuel

When General Electric brought out the LM2500+ gas turbine with 35,000 HP in the late 1990s, it was a logical step for the U.S. Navy to equip new ships with this propulsion plant due to the clear advantages of gas turbines over the steam turbines previously used: Performance being equal, they are not only more compact, lighter, and easier to maintain, they are also quicker to get running and require less manning. So the latest large-deck assault ship, the Makin Island (named for an atoll in the Pacific), which went into service in 2009, is powered by two LM2500+ gas turbines. At speeds under 12 knots (just over 22 km/h), two 5000-HP

The USS Makin Island went into service in 2009 and is the first large-deck assault ship in the U.S. Navy to be powered by gas turbines.

Simulating Gas Turbine Ship Propulsion Plant

Turbine on Board

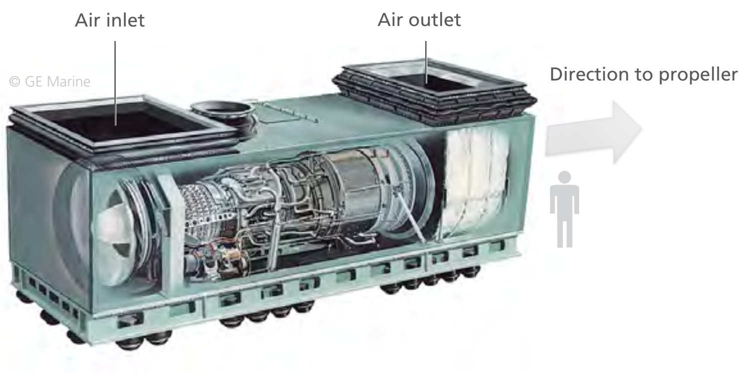


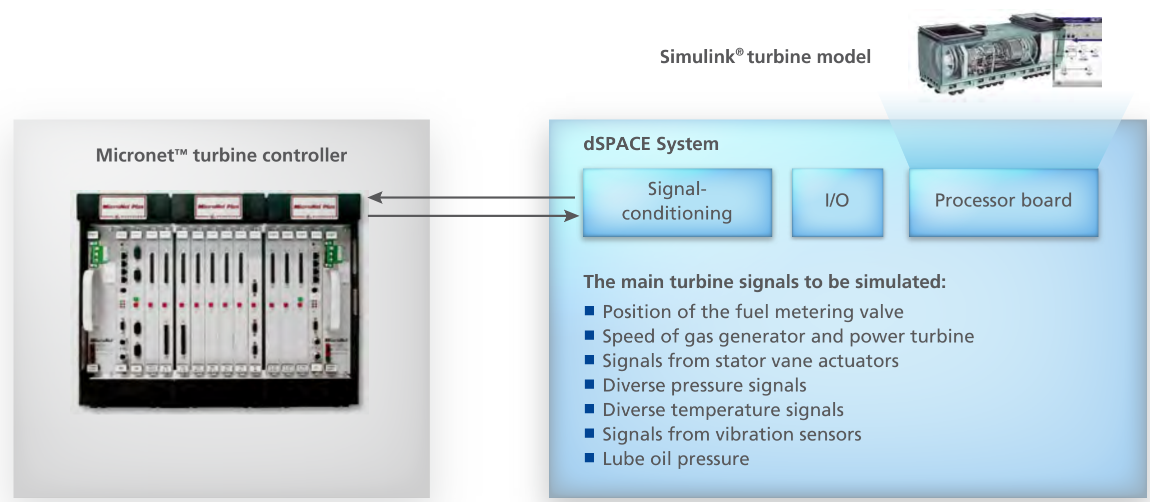
Figure 2: The Makin Island has two LM2500+ type General Electric gas turbines that together generate 70,000 shaft horsepower. A dSPACE system was used to test the Woodward Governor Company MicroNet™ ECU.

electric motors take over propulsion, saving up to 25% of the gas turbines' operating time and approx. 1.5 million liters of fuel every year. Because the Makin Island is the first ship in the U.S. Navy to use the LM2500+ turbine, the associated control software had to be completely readapted and tested. This work required shipboard simulation of all the signal traffic between the electronic control unit (ECU) and the gas turbine, so a powerful, simulation-based, extremely flexible real-time test system was needed.

Simulating Signal Traffic

Northrop Grumman's engineers faced the paradoxical task of testing the ECU's turbine emergency shutdown and warning functions without actually operating the turbine, since this was a condition of their contract with the U.S. Navy. The ECU was significantly different than its counterparts on other ship classes, and actually had to monitor a normal engine startup prior to engaging the engine's protective features. The only way to do this was to simulate the turbine's signals to make the ECU "think" that the turbine was really running. Simulating turbine startup was a major challenge for the test system, because during the start sequence the ECU expects the turbine to send numerous signals (temperature, pressure, speed and so on) with specific values and rates-of-change at various points in time. If these return signals do not fit the expected reference values, the ECU immediately aborts the start sequence. "Unfortunately, it was not possible to use manual settings to trick the ECU into its Run status," explains James Turso, an engineer at Northrop Grumman. "So we had to simulate the complex start sequence before we could begin testing the ECU's turbine emergency shutdown and warning functions."

Figure 3: To test the MicroNet™ ECU, a dSPACE system simulates all the signal traffic between the turbine and the ECU. The turbine model was developed in MATLAB®/Simulink®.



Choice of Test System

For gas turbine simulation, engineers at Northrop Grumman specified a hardware-in-the-loop (HIL) simulator that had to fulfill a whole series of requirements:

- Real-time capability with a maximum model throughput time of 5 ms (the turbine model was developed in MATLAB®/Simulink®)
- Signal conditioning capability (to exchange signals with the Woodward Governor Company MicroNetTM ECU)
- All sequences software-controllable
- Uncomplicated, flexible connection of test hardware to the ship's electrical system, i.e., without adapting the ECU, the gas turbine or the cabling
- Fail-safe, industry-proven system

To be certain of meeting this requirement profile, Northrop Grumman decided to use modular hardware and software components from the dSPACE tool chain.

dSPACE System Simulates Gas Turbines

To present a realistic operational gas turbine to the ECU, the dSPACE system had to simulate a wide range of different turbine signals (figure 3): signals for pressure, temperature and acceleration, the speeds of the gas generator and power turbine, lubricant pressure, etc. "But the biggest challenge was to simulate the signals of the fuel metering valve position feedback signal, which works on the principle of an LVDT," adds James Turso. An LVDT (linear variable differential transformer) is an inductive sensor that generates a high-frequency AC voltage signal with a variable amplitude. In the Makin Island's gas turbines, the signal shape depends on the current opening of the fuel valve, which changes constantly throughout the start sequence (figure 4).

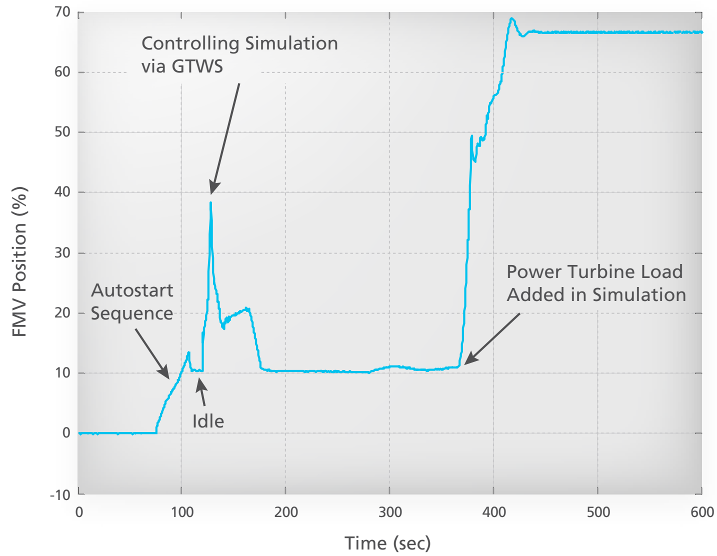


Figure 4: Time behavior of fuel metering valve position (actually the position feedback signal from the dSPACE equipment processed by the ECU) during the propulsion system's startup sequence. Simulating the LVDT for this was the greatest challenge in the tests.

> "Given the tight time constraints on this project, the dSPACE system enabled us to meet the U.S. Navy's tough gas turbine ECU test specifications."
>
> *James A. Turso, Northrop Grumman*

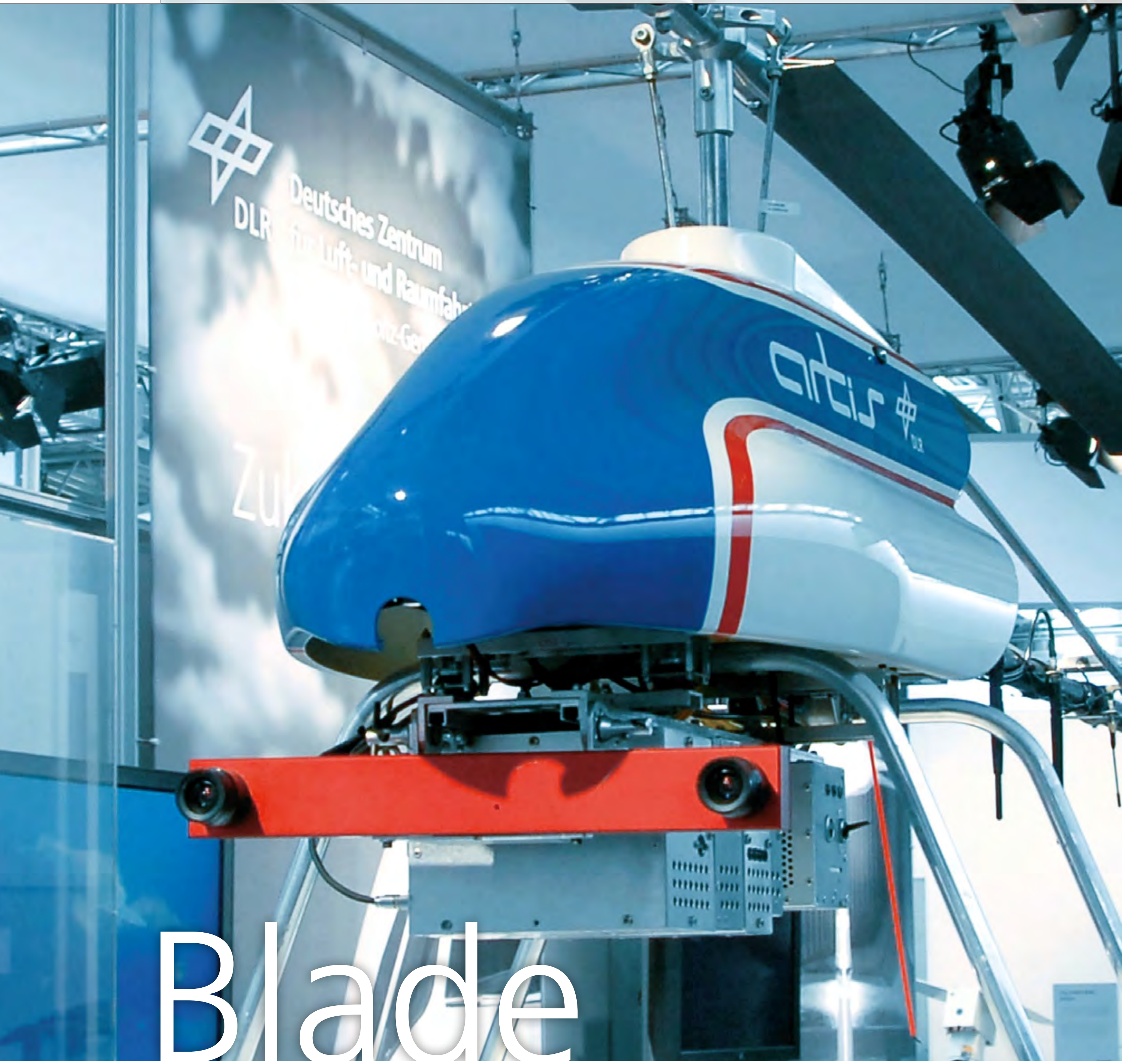
"With the dSPACE HIL system, the simulation of this complex signal works perfectly," concludes James Turso.

All Tests Successful

With the aid of the gas turbine simulation by the dSPACE HIL system, Northrop Grumman engineers brought the various ECU safety and emergency shutdown function tests stipulated by the U.S. Navy to a successful conclusion. The dSPACE HIL system proved its high flexibility in all these tasks and will be used again in any future new-engine startup tests. And as all forms of shipbuilding face increasing complexity, such a HIL system would also be invaluable in testing control systems for other types of components. The days when tests could be performed just by adjusting controls and switches manually are fast coming to an end. ■

James A. Turso Ph.D., P.E
is a Fellow engineer at Northrop Grumman, USA.

Source : Proceedings of ASME Turbo Expo 2010: Power for Land, Sea and Air GT2010
June 14-18, 2010, Glasgow, UK
GT2010–223050



Blade Runner

Developing and testing intelligent autonomous aircraft

In *Do Androids Dream of Electric Sheep?*, a science fiction story by Philip K. Dick and later the action film *Blade Runner*, a central question is whether autonomous, high-tech machines are capable of dreaming. If they are, what do the German Aerospace Center's unmanned research aircraft ARTIS and Prometheus dream of? They dream of their experimental flight environment, of possible missions and, even more exciting, of missions yet impossible.

Prometheus, the newest member of the Institute of Flight Systems' research fleet.

DLR's research UAVs (like ARTIS here) contain numerous onboard systems. These are used for stabilization, flying preset trajectories, automatic take-off and landing, and so on.

Mission Impossible

The missions under investigation by researchers at the German Aerospace Center's (DLR) Institute of Flight Systems are dangerous, dirty, and dull. Only missions like these justify the expense of developing unmanned aircraft. For all other missions, the hand on the control stick has always been, and will always be, human. But wherever someone – or something – has to enter an obstacle-ridden scenario, investigate a disaster site, fly at high risk under extreme conditions, or make tedious relay or inspection flights, unmanned aerial vehicles (UAV) come into their own. In theory. And to some extent in practice: Modern UAVs can fly along preplanned waypoints, and some can take off and land automatically. However, there is not a single UAV that is allowed or even able to operate in Germany's general airspace, because at the moment, they quite simply lack the ability to "see" their environment and react to it appropriately.

Artificial Sensory Organs

This is where the research begins. To perceive its environment, a UAV needs additional equipment such as image sensors for a two-dimensional, or even better, three-dimensional view of its surroundings. Cameras, radar and laser scanners can all be used. The captured sensor data must then be processed in real time so that the results can be used for flight control. A decision system or mission manager also has to be developed; this will receive environmental data and UAV-specific data and use it to assess options, make decisions, and if necessary even change the route or abort the mission in an emergency. The flight controller also has to meet tougher requirements, especially with regard to its precision and its ability to utilize the aircraft's maximum flight performance.

Flying Research Platform

But before even beginning to tackle these demanding tasks, a suitable research platform and infrastructure have to be set up. Looking round the market to find a suitable experiment platform, one very quickly realizes that an off-the-shelf system will never fulfill these very particular research needs. Only a custom development can provide the necessary combination of special, powerful, modular sensors and processors, open interfaces and easy programmability to meet the need for a large payload and good usability. It also covers certification aspects and customer expectations, and ensures that the basic system, measuring equipment, onboard electronics and flight control processor are optimally coordinated.

Technical Components

The research platforms that were developed consist of flight control computers, different data commu-

World modeling and mapping in real time during fully automated flight over unknown terrain.

nication devices, a high-precision GPS receiver system, a three-axis acceleration and rotation speed sensor, and a sonar device for measuring the altitude above ground. A three-axis magnetometer is also included. These modules are all needed to stabilize the UAV, to fly it on preset trajectories, and to have it take off and land automatically. The individual vehicles are all fitted with the same sensors and control processors. Each of the three ARTIS helicopters (midiARTIS, meARTIS and maxiARTIS) implements a different drive concept: two-stroke engine, electric drive or turbine. The rotors are between two and three meters in diameter, and the maximum take-off weight is 25 kg. Prometheus, in contrast, is a pusher propeller airplane with a twin-tail unit. Collectively, these aircraft cover tasks that demand highly precise navigation in a confined space, and also tasks that require a long range and high flying speed.

Mathematical Description of Flight Behavior

While the real flying system is being set up, a mathematical description of the system's mechanical flight behavior also has to be developed. This is the basis for setting up a flight controller that will automatically stabilize the aerial vehicle and steer it towards waypoints. Physical relations and captured data (from wind tunnel tests, for example) are combined to create a simulation model of the aerial vehicle. The model's parameters can be determined precisely by applying the same control inputs to the real flying system and to the model, recording the responses of both, and minimizing the differences between their responses by adjusting the model parameters. If the model's behavior and the real behavior are not consistent enough, the model can be extended or refined in an iterative process. The result is a precise, numerically and analytically accessible description of the controlled system.

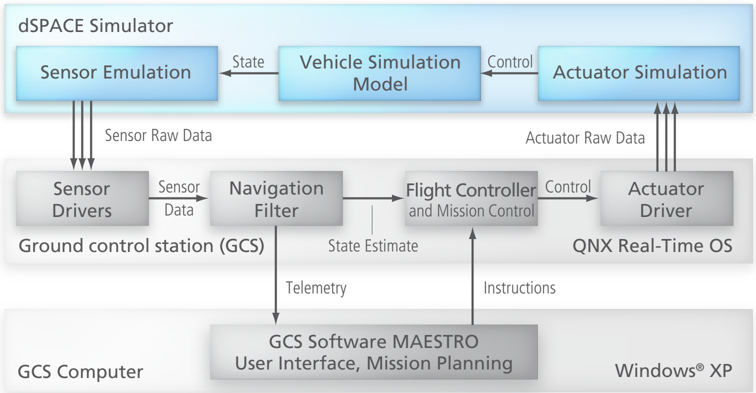
Developing a Flight Controller Model

This model was implemented in MATLAB®/Simulink® and then immediately used to develop the controller in a desktop simulation. However, to perform its tasks, the flight controller requires precise information on the vehicle's attitude and position, so the navigation algorithms also had

ARTIS, the Autonomous UAV

At the DLR's Institute of Flight Systems in Braunschweig, Germany, researchers are using small unmanned helicopters to develop an experimental aerial vehicle called ARTIS (Autonomous Rotorcraft Testbed for Intelligent Systems). The project aims to investigate new kinds of systems and algorithms for autonomous, intelligent functions and evaluate them in experiments. In addition to an onboard computer and data link, ARTIS has a variety of sensors such as satellite navigation (GPS), an inertial measurement platform and a magnetometer. Imaging sensors (such as video cameras) are extremely important. Functions for machine decision-making, collision avoidance, and cooperation between several flight systems are major research focuses, in addition to advanced flight control and flight guidance concepts. Real-time image processing systems are also used for experiments on optically supported navigation and world modeling.

Hardware-in-The-Loop Simulation Environment



The dSPACE system simulates all the sensor data, so for the UAVs, the simulated flight in the laboratory is just like a real flight.

to be included in the simulation. Since navigation uses the individual sensors, these were also represented in the simulation with their protocols and their noise and time behavior. These sensor simulations take the data they need from the simulation of flight mechanics. The simulation also includes a wind and gust model, plus a ground contact model for take-off and landing. An interface to the UAV's ground control station was set up for easy and realistic handling. Another interface to the outside world allows the position and attitude of the simulated system in its environment to be visualized. All these elements make it possible to plan, fly and observe entire missions in the laboratory. Controller development, parameter tuning, protocol tests, communication tests, and test flight preparation can all be performed within this infrastructure.

Real-Time Simulation

This approach cannot be used to investigate the functioning and behavior of the flight control computer, especially with regard to its real-time capability and correct connection to the hardware interfaces. A dSPACE system provided the solution: to partition the simulation, largely using the same function blocks that were developed under Simulink. The navigation and flight controller were taken out of the simulation and performed by the original flight control computer instead. All other functions were ported to the dSPACE system, where they provide real-time simulation of the sensors, the environment, the flight mechanics and the actuator dynamics. Additional conditions such as wind, sensor noise and the failure of entire sensors can easily be set in the dSPACE ControlDesk® experiment software.

Flights in the Lab

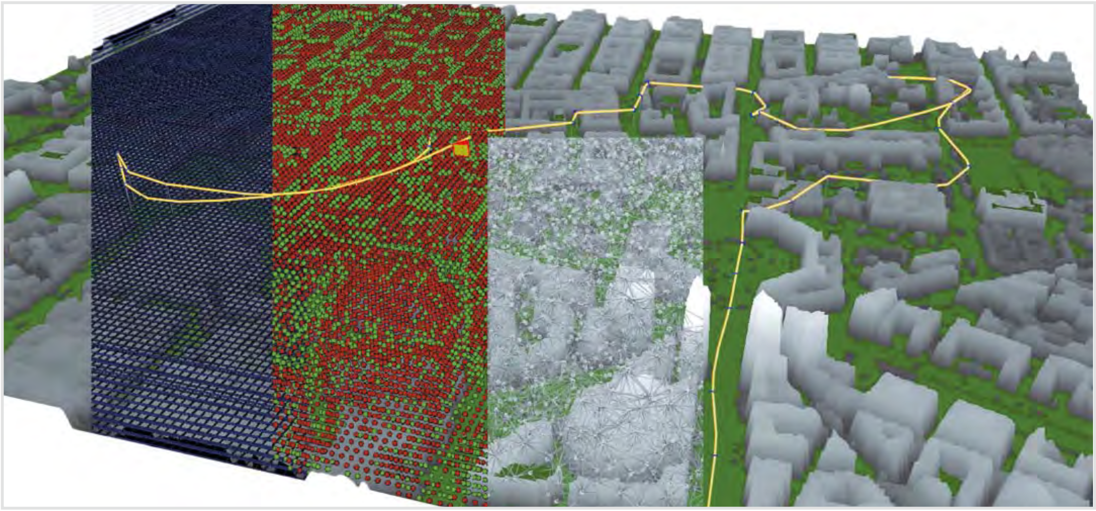
In practical terms, all the sensors are simply disconnected from the flight control computer and substituted by dSPACE-simulated sensor data via compatible connector plugs. The flight control computer processes the serial data with the original drivers and settings, computes a navigation solution, and generates a command. The command is directly executed via the original actuators and also returned to the dSPACE system. The latter uses the command itself, the system dynamics and the environment to calculate a response to the command, and then simulates the corresponding sensor data. To return to the image of the dreaming aircraft: The UAV dreams of its mission and reacts accordingly, all the time sitting safely in the laboratory.

System Tests

This kind of hardware-in-the-loop (HIL) simulation has proven to be extremely useful and is being used intensively in development. Subsystem tests, final system tests, algorithm adjustment, interface tests, etc., are always performed in this environment. The simulation is also combined with the powerful visualization environment and used for

> "Two factors contribute to the successful development of unmanned aerial vehicles, but they are seldom mentioned and always underestimated: the safety pilot and the dSPACE system for hardware-related simulation. Both of them considerably reduce the 'drop height' of test flights."

Dr.-Ing. Gordon Strickert, German Aerospace Center (DLR)



Automatic route planning in complex low-level flight scenarios.

parameter studies, quality management and, last but not least, real-time presentations.

Virtual Flying Class

The UAVs have by now learned to fly in this simulation environment: beginning with careful hovering for the helicopters, then waypoint flight, automatic take-off and landing, and finally even aggressive rapid flight along what are called three-dimensional spline paths. Methods of automatic world modeling and processing, and of three-dimensional map creation, are currently being tested here. This means that the new environment sensors also have to be integrated into the HIL simulator for simulation.

Real Missions

The experimental aerial vehicles regularly have to withstand the test of real flight missions. The cables to the dSPACE system are removed for these, and the normal sensors are connected. Software modifications or reconfiguration are not necessary. Thanks to uncountable hours on the simulator, the system behavior is already known with sufficient precision, and test flights seldom produce surprises. The team can concentrate fully on real, non-simulated effects and complications.

Autonomous Helicopter

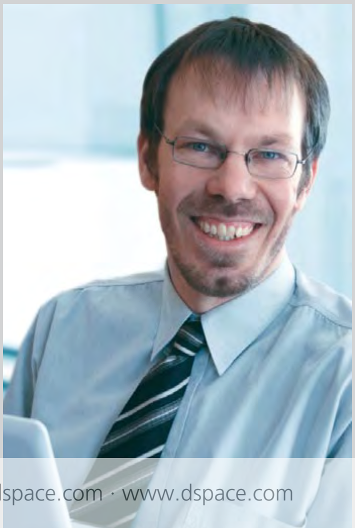
As a result of this work, ARTIS is one of only a few automatic helicopters in the world that can move across unknown terrain, create a map of their environment completely independently, and operate within that environment collision-free. The test flights are turning what were once machine dreams into tangible, measurable realities. ■

Dr.-Ing. Gordon Strickert,
DLR Braunschweig

In Brief

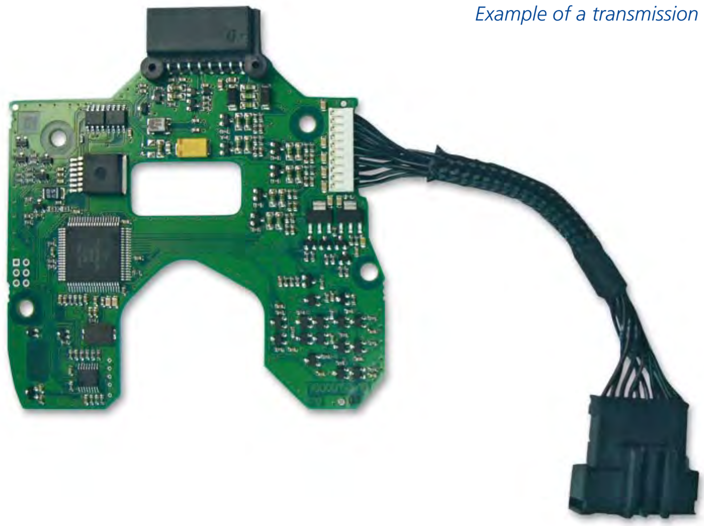
- Developing autonomous unmanned aerial vehicles
- Simulating complex spatial environment models in real time
- Optimizing the controller on the dSPACE Simulator

Dr.-Ing. Gordon Strickert
Dr. Strickert is a research associate developing unmanned flying aircraft at the DLR's Institute of Flight Systems in Braunschweig, Germany.



Testing transmission lever electronics automatically with dSPACE test automation

Tested and found good



Example of a transmission lever electronics component.

A higher degree of automation, higher quality, higher efficiency, higher test reusability: These were the goals of Lemförder Electronic GmbH. The company achieved them all by using a dSPACE HIL simulator and dSPACE AutomationDesk.

Lemförder Electronic GmbH develops, produces and distributes electronic and mechatronic components, including transmission lever electronics for the automotive industry. The company has constantly to adapt to ever-tougher requirements for electronic components in vehicles, such as modules that are becoming more compact yet have more and more functions. The transmission lever systems for automatic and manual transmissions that used to be purely mechanical components have evolved into mechatronic systems with microcontroller-based ECUs. And fulfilling the requirements for functional safety plays an important role, especially with integrated shift-by-wire functionality, in which the gear shift input is transmitted via the vehicle bus.

Lemförder Electronic achieves this functional safety by subjecting all the electronics hardware and software to different test stages before shipment, conducting module, integration, system, function and release tests. All this requires a powerful test environment.

In the Beginning Was the Test Box

Up to a few years ago, Lemförder Electronic only used test boxes to test transmission lever electronics. The test boxes acted as substitute transmissions, and single assemblies were created individually. They were optimally tailored to specific test requirements, but it took longer to plan and develop them. Tests were performed by stimulating each test box, meaning each gear variant, either manually or by actuators. As the number of variants and the level of function integration grew continuously, so did the work involved. It was no longer possible to achieve precise reproducibility.

The Goal: Automated Testing

To boost the efficiency of creating and executing tests, and to simplify their reuse, Lemförder decided to introduce a new test concept. Consisting of hardware-in-the-loop (HIL) simulation and test automation, this would increase the number of tests and improve their quality. In parallel to that, the previously used test boxes would also be supplemented by the new HIL hardware.

New Test Landscape

Lemförder Electronic achieved these goals by using a HIL simulator and test automation software from dSPACE. The test automation is based on AutomationDesk® with Real-Time Testing and ControlDesk® from dSPACE, and is supplemented by the DOORS® requirements management tool from IBM Rational®. The tests are specified and managed in DOORS®. Test cases are created and executed under automatic control in AutomationDesk. The current parameter settings can be monitored during simulation from within ControlDesk.

> "AutomationDesk simplifies test creation and quickly boosts testing depth."

Knut Schwarz, Lemförder Electronic GmbH

Lemförder Electronic GmbH

Lemförder Electronic provides solutions for electronic components and systems as well as services for the automotive industry. The company develops, produces and maintains all the products itself. The range covers the entire process chain, from individual feasibility studies to development, prototype creation, strategic materials purchase, flexible production and reliable logistics.

Use in Production

dSPACE engineers were on site during the startup phase for the new system. They supported test personnel during introduction, helped put the test system into operation quickly, and sped up the learning process. Since then, the system has become an integral part of the product creation process. Configurations were set up for the different variants of the transmission lever electronics on the HIL simulator, and automated tests were developed in AutomationDesk. A layout with virtual instruments was created in ControlDesk to adjust test settings manually if required. A strict library structure with predefined test steps was introduced so that tests could easily be reused, even in projects for different OEMs and other Lemförder Electronic product groups.

Results

As projects were carried out, an extensive test library with hundreds of test cases grew. The test cases can be used flexibly for the ECU variants and also greatly increase testing depth. With automated HIL tests and associated test report creation, test runs can now be made overnight and on weekends. Customers can be given the automatically generated test reports whenever they need. Using the system in different development phases means that errors are detected at an early stage, and that error removal is verified by regression testing. When modification requirements are received, Lemförder Electronic can implement them faster than they used to, because only the HIL simulator and the test sequences need to be adapted. The new technologies

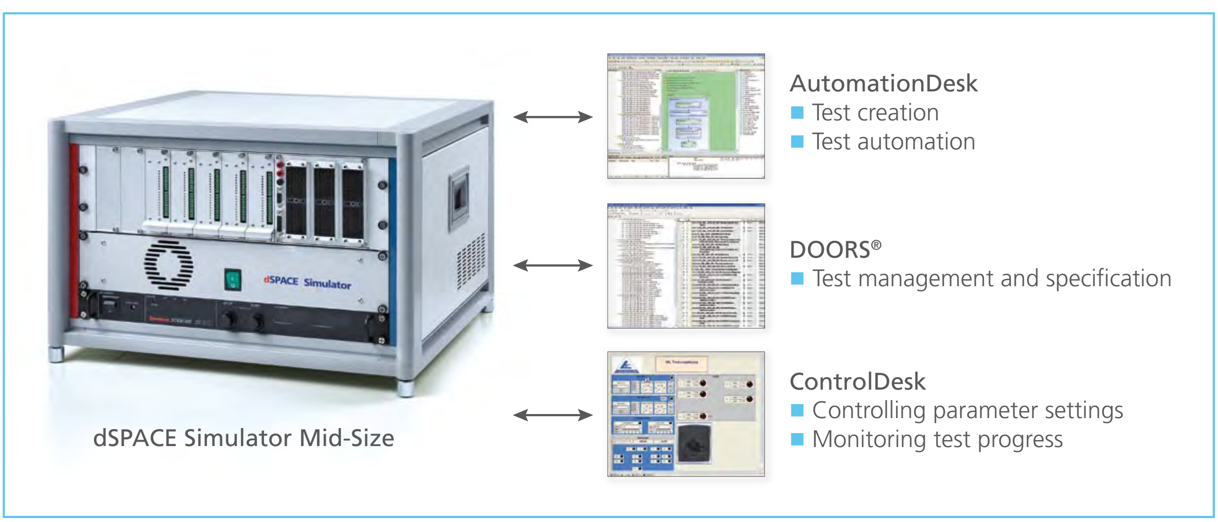


Figure 1: Setup of the HIL system: dSPACE Simulator with AutomationDesk, ControlDesk and DOORS®.

	Software Shipment Test/Basic System Test	Complete Function Tests	Functional Validation of Single Modules	Endurance Tests
Application Case	Testing all the function groups in the transmission lever electronics.	Testing all the function groups in the transmission lever electronics (positive and robustness tests, black box tests).	Testing individual aspects with different parameter settings in real time.	Testing transmission lever electronics in continuous operation.
Test Volume	Approx. 50 - 70 test cases	Over 1000 test cases	n.a.	n.a.
Duration	30 - 45 minutes	0.5 - 0.75 days	n.a.	Approx. 500 hours
Users	Test engineers; Software developers (version-responsible)	Test engineers; Software qualification team	Development engineers for hardware and software	Software qualification team

Figure 2: The four main areas in which dSPACE Simulator is used. The system is used by different users with different concerns.

increase overall test efficiency and ensure consistently high quality. The simulator is a great support, especially in robustness tests, in which the electronic component under test is fed with input values to evaluate whether it functions correctly even with invalid input values and in extreme environmental conditions. The functional behavior must be robust enough to always reject invalid values and call suitable error routines.

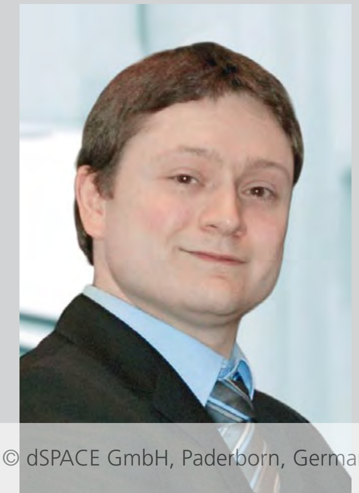
Outlook

In view of the good results obtained from HIL, Lemförder is extending the test process. Now, HIL tests will not only be used to increase testing depth, but will also be performed even earlier in each project. Easier handling means that more development software qualification team members can access the system.

Knut Schwarz,
Michael Eimann,
Lemförder Electronic GmbH

Knut Schwarz
Knut Schwarz is a software team leader at Lemförder Electronic GmbH in Espelkamp, Germany.

Michael Eimann
Michael Eimann is a software development engineer at Lemförder Electronic GmbH in Espelkamp, Germany.



Conclusion

Lemförder Electronic's goal was to increase the efficiency of electronic components testing and respond to modification requirements faster. They chose a test system from dSPACE consisting of a HIL simulator and test automation. Their test processes were improved by factors such using the HIL system at an early phase in the development process and by a rapid increase in testing depth.

Flexible work processes with new simulator technology

The Status Quo of HIL Simulation

In numerous companies, hardware-in-the-loop (HIL) simulation is an integral part of the electronics development process. Central HIL departments are often set up to run tests, though sometimes the engineering departments take care of their HIL systems themselves.
In either case, teams solely dedicated to HIL are typical. Their fundamental tasks are to design the electrical aspects of the simulator (HIL hardware, connections for real loads and substitute loads, cable harnesses), to model the I/O and plant, and naturally to create and execute tests. The logical consequence of this is specialization, or task division, amongst the members of a HIL team. The resulting tasks need optimum support from powerful tools.

Flexibility is Key

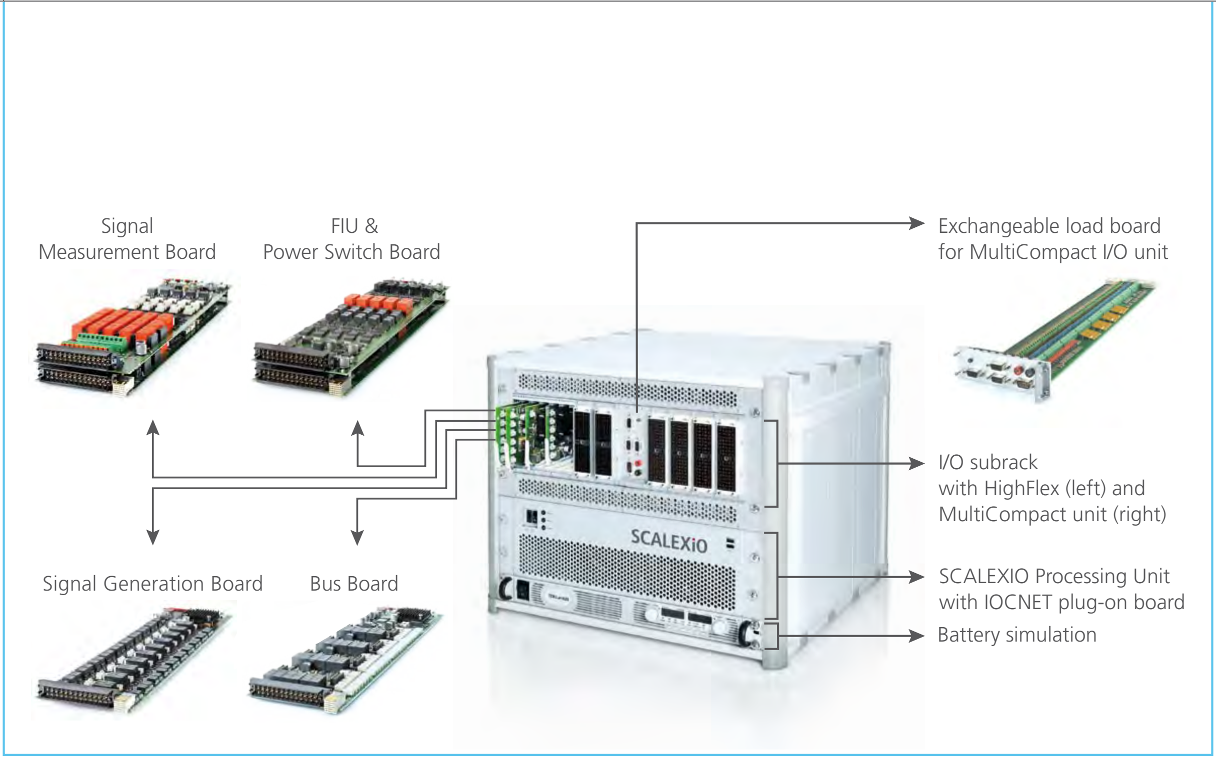
HIL systems for network testing of the entire vehicle electronics are sometimes specified and built at a point in time when parts of the ECU specifications might still change. This makes tough demands on the flexibility and quick adaptability of the simulator. Flexibility is also essential when different ECU variants have to be tested singly or in a network. The same applies to testing new components for vehicle platforms that are already in production.

Maximum Scalability

In real-world testing, the ideal solution would be to use the same HIL system to test the ECU network and the individual components. This might be done to concentrate the error search on a single ECU on an isolated subsimulator, or it may be that after successful component tests, the single simulators are to be interconnected to make a network simulator at a later stage of development. All this places tough demands on the system's modularity, scalability, and extensibility.

SCALEXIO

Hardware-in-the-loop technology for testing electronics has become an established industry method. Users' workflows have changed in many ways, and to ensure the greatest possible productivity in the development process, a new product concept is needed. The answer is SCALEXIO.



A SCALEXIO system configuration with the different I/O boards.

High Productivity

The time and cost spent on the first setup and on later adjustments and conversions must be kept as low as possible. Ideally, it would be best to produce new configurations at the push of a button. The testing and documentation of systems also plays an important role in this context, not least because the introduction of the ISO 26262 standard for the development of safety-critical systems will require precise documentation of the test systems.

SCALEXIO®, the New HIL Technology

Systematically implementing these identified requirements in a HIL test system will necessitate some a radical change of direction in existing hardware and software concepts. That is why SCALEXIO, the new HIL technology, is based on a completely new hardware and software architecture. Its outstanding features are high channel flexibility, granular extensibility and complete software configurability.

Real-Time Processor with Quad-Core Processor

At the heart of SCALEXIO is a real-time processor. This sets up a connection to the host PC via Gigabit Ethernet. The connection is used to configure the entire simulator, load real-time applications, and finally monitor and control the HIL simulation itself. A SCALEXIO processor core is based on an industry PC with an Intel® Core™ i7 quad-core processor, a real-time operating system (RTOS), and a PCIe plug-on card developed by dSPACE for communication with the I/O and with further real-time processors. Using standard PC technology means that performance and technology innovations can be harnessed as soon as they come on the market.

Internal Communication

For internal communication between the real-time processor and the I/O boards, dSPACE developed a new communications protocol, IOCNET (I/O Carrier Network). IOCNET is based on Ethernet and allows more than 100 I/O devices to be connected to a SCALEXIO system, all of which can be many meters apart. This makes it possible to implement widely distributed systems, addressing the requirements for modularity and flexibility. To guarantee dSPACE's accustomed real-time capability, the protocol was designed for real-time communication and highly precise time and angle synchronization.

SCALEXIO: More flexibility in HIL projects

The transmission rate that can be achieved with IOCNET is around 10 times higher than with the previous technology.

Two I/O Board Types

The HIL signals can be roughly divided into four classes: signal generation (e.g., simulating sensor signals), signal measurement (e.g., measuring actuator signals), bus systems and supply signals. The SCALEXIO technology provides two different, software-configurable I/O board types for these four classes: the HighFlex I/O boards and the

SCALEXIO systems are extremely scalable.

MultiCompact I/O unit. What both types have in common is a local PowerPC processor for preprocessing signals and relieving the load on the real-time processor, an IOCNET interface, typical signal conditioning for automotive applications, converters, and parts of the electrical failure simulation. The two I/O board types can be combined in any way desired and used in small component testers and also in large network test systems. Integrating the signal conditioning and failure simulation reduces internal wiring and simplifies the technical setup, which makes reuse much easier.

HighFlex I/O Boards

The outstanding features of the HighFlex I/O boards are flexibility and performance. Each of the signal generation and measurement boards provides 10 separately galvanically isolated channels. The physical interface type of each channel is software-configurable, e.g. as a digital or analog interface, or as a resistance simulator. The bus board contains 4 galvanically isolated bus channels that can be software-configured as CAN, LIN, FlexRay or UART and that

SCALEXIO: Easily reused for further test tasks

provide the necessary transceivers and terminations. When a simulator is designed with HighFlex I/O boards, only the number of channels has to be taken into account and not their types. The physical interface that is actually used is configured via software and can be changed as often as required. This all adds up to a very high level of flexibility and reusability. All HighFlex I/O boards have the same connector concept. This ensures that they can be mounted in any slot, which makes it a great deal easier to build and adapt a SCALEXIO system.

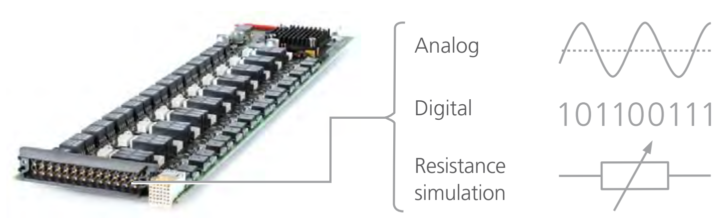
MultiCompact I/O Unit

The MultiCompact I/O unit currently available is tailor-made for powertrain and vehicle dynamics applications. It has a total of over 150 channels and is galvanically isolated as a unit. The channels are mainly dedicated rather than multifunctional to ensure compactness, a high channel density and a favorable price per channel.

Hardware Setup

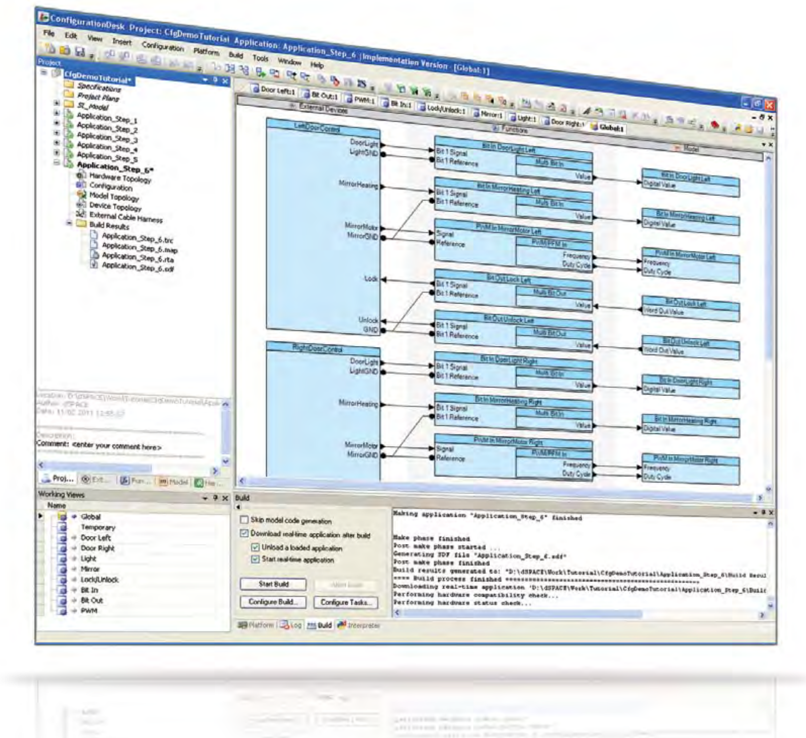
Using as many off-the-shelf components as possible, plus simple, standardized 10-channel wiring, will dramatically reduce the work involved

The channels of the HighFlex I/O signal generation board are physically configurable for analog and digital signals and for resistance simulation.



Summary and Outlook

SCALEXIO fulfills all the new requirements that hardware-in-the-loop (HIL) users have encountered over the years. Its cutting-edge hardware and software architectures are a complete response to the changes and new challenges in today's HIL projects. The potential of the SCALEXIO technology was already thoroughly tested and confirmed in customers' evaluation projects and concrete pilot projects. The first version of the SCALEXIO system is ideal for projects in the areas of powertrains and vehicle dynamics. Later versions will see the addition of further MultiCompact I/O units tailored to other application areas such as body applications, which typically require a lot of digital I/O.



ConfigurationDesk provides a convenient user interface for quick I/O configuration.

SCALEXIO: Lower costs and faster progress

in configuring, setting up, testing and documenting a simulator. All the system components, such as the real-time processor, HighFlex I/O component carrier, MultiCompact I/O unit and battery simulation power unit are installed in standard 19" cabinets. The combination of software configurability, multifunctionality and preinstalled signal conditioning, plus failure simulation on the I/O boards, means that a simulator can often be adapted simply by replacing the external cable harness. SCALEXIO's component design also considerably increases efficiency.

Simple Configuration via Software

Users can easily access the SCALEXIO hardware's versatile configuration options from the new Configuration-Desk® tool. The I/O functions are configured at an abstract, logical level, and not on any specific hardware channel. This means, for example, that functionality can be reassigned to another I/O board, and it is even possible to use several physical channels with one I/O-function if the current/voltage limit of a signal has to be increased. This abstract configuration level also allows virtual project planning while the HIL hardware setup is still evolving, so that configuration work can begin very early in a project. The (incremental) build process is also run from within ConfigurationDesk, resulting in an executable real-time application that can be loaded straight to the HIL simulator.

Coexistence of I/O and Plant Models

Separating the I/O configuration from the plant model enables modular, reusable configurations. This gives better support to new workflows and to parallel work on different tasks. This in turn saves time, because when modifications are made to the I/O, only new I/O code is needed, and there is no need to touch the code for the plant model.

Convenient Configuration Process

The configuration process is roughly divided into three tasks: describing the externally connected devices (e.g., ECUs, real loads), selecting the I/O functions for each signal, and linking the I/O functions to the plant model. Configuration can be performed in any order in a clearly organized 3-column display.

Other Software

In addition to ConfigurationDesk, other familiar dSPACE software is also available for SCALEXIO:

- ControlDesk® Next Generation for instrumentation
- AutomationDesk® for test creation and automation
- Real-Time Testing for clock-synchronous execution of real-time test scripts and the simulation model
- MotionDesk for visualization
- ModelDesk for graphical model parameterization
- Automotive Simulation Models for real-time simulation models
- CAN and LIN MultiMessage Blocksets and the FlexRay Configuration Package for restbus simulation

These are the ideal basis for a HIL testing.

Interview

with Susanne Köhl, Lead Product Manager for Hardware-in-the-Loop Simulators

Ms. Köhl, why did dSPACE develop a new technology for HIL simulation?
The new technology is needed to provide optimum solutions for the changing requirements our customers are encountering in their HIL projects.

What is really new about SCALEXIO?
Everything in SCALEXIO is brand-new technology: from the processor board, the internal bus for communication with the I/O, and the I/O boards tailor-made for HIL applications, to the hardware setup, and the software support for hardware configuration.

How do users benefit?
SCALEXIO provides targeted support for customers' individual workflows, such as the separate roles of plant modelers and hardware specialists. SCALEXIO gives projects more flexibility: SCALEXIO systems can be planned and modified quickly and easily. Different ECU variants and types can be tested on one system, and it is easy to implement system extensions at a later date.
Using the same components for large network testers and small component testers ensures seamless transitions between different test tasks.
And last but not least, time and costs are saved by simplified system assembly and modification, and because software-based configuration means automatic system documentation.

Can existing HIL systems still be used?
Yes, of course. And SCALEXIO can also be connected to existing HIL systems via processor-to-processor coupling. With ControlDesk Next Generation, the two systems can even be handled from within one layout. The host PC performs measurement synchronization.

Will SCALEXIO replace the PHS-bus-based systems?
Yes, in the long term, we'll continue expanding SCALEXIO so that it can replace the PHS-bus-based systems. But we feel that both systems will exist side by side for a very long time, so everyone has a completely free choice of system.

Ms. Köhl, thank you for talking to us.

New Option for MicroAutoBox II Combines the Best of Two Worlds

Twice the Punch

A new option for dSPACE's MicroAutoBox II prototyping system combines a real-time processor unit and a Windows/Linux-capable embedded PC, the MicroAutoBox Embedded PC. These form a single, powerful system that is ideal for the new trends in vehicle electronics development, and is also just as suitable for nonautomotive applications.

The Demands of Advanced Driver Assistance Systems

The desire for greater road safety and less CO_2 emissions is a major force for innovation in the automotive industry. A prime example is the increase in development activities for advanced driver assistance systems in new generations of vehicles. Reliable recognition of the vehicle's environment and traffic

Figure 1: Everything in one box – the new MicroAutoBox II with integrated Embedded PC and Ethernet switch.

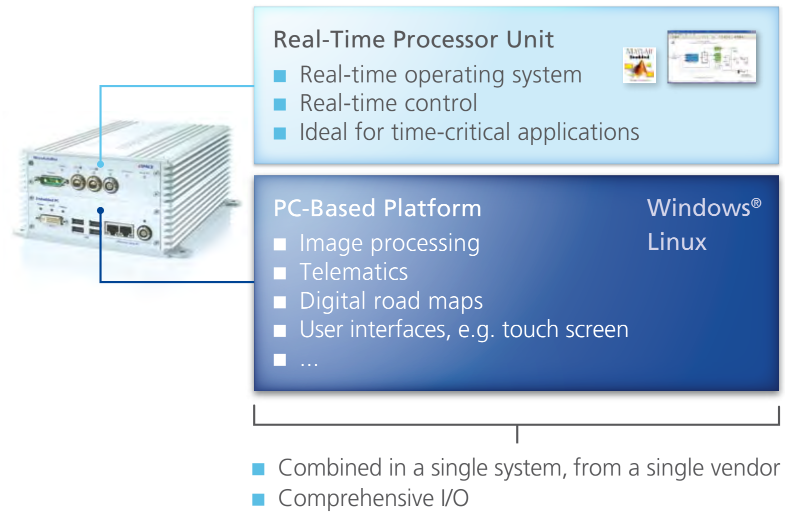


Figure 2: All-rounder – dSPACE MicroAutoBox II with integrated Embedded PC and characteristic simple wiring and numerous switching options for autonomous operation.

situation is at the heart of such systems. Capturing data by video cameras and video processing are essential in this context, as well as covering greater ranges ahead of the vehicle.
One approach to this is based on the predictive evaluation of digital road maps. Another relies on communication between the vehicle and its environment via WLAN or mobile communications.

Embedded PC for Telematics, Image Processing and Digital Map Data

In ECU function prototyping, tasks such as predictive road map evaluation, computing telematics software, and object recognition based on camera data typically run on an embedded PC. The actual control function – for adaptive cruise control (ACC), emergency brake assistants, etc. – runs on the real-time processor unit, which is networked with the ECUs in the vehicle via the bus system.

All-in-One Development Platform

MicroAutoBox II with the integrated Embedded PC is tailored to developing such systems. It contains a real-time processor unit and a Windows/Linux-capable embedded PC within the same overall system. This gives users an IBM PowerPC with a real-time operating system and very low worst-case response times, plus an Intel® Atom™ processor (1.6 GHz), both with numerous interfaces. The Embedded PC also has 2 GB RAM and a 2.5″ SATA hard disc (HDD) or solid state drive (SSD). An integrated Gigabit Ethernet switch lets the host PC address the real-time prototyping unit and the Embedded PC via the same Ethernet cable. The switch and the implementation of the Ethernet interfaces were chosen specifically to ensure low communication latencies at a high data throughput. Simulink® blocksets are available to easily model the Ethernet interface on the embedded controller.

> The integrated solution for developing advanced driver assistance systems

Complete, Compact System for In-Vehicle Use

The new extended MicroAutoBox II is perfect for in-vehicle use: It has a compact, robust design, is very simple to wire, and its real-time prototyping unit and Embedded PC can be switched on and off synchronously. For example, the entire passively cooled system can be remote-controlled via the vehicle's ignition switch. Alternatively, the individual units can also be powered up and shut down separately. The input

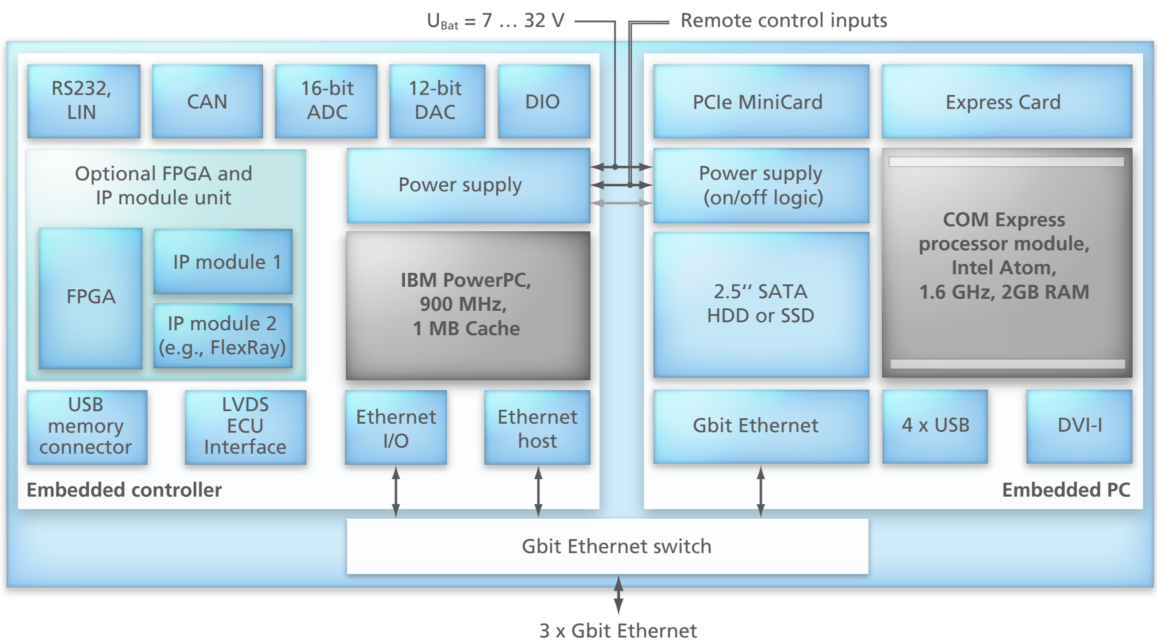


Figure 3: Block diagram of MicroAutoBox II with embedded controller and Embedded PC.

voltage range of 7 to 32 VDC, the sleep-mode current consumption of under 5 mA, and the overvoltage protection of the Embedded PC are all designed for permanent installation in a vehicle.
The possible uses of MicroAutoBox II are not restricted to the automotive field. It is just as helpful in fields such as industrial automation, robotics, medical engineering and aviation technology. Its applications are practically unlimited.

Numerous Interfaces and Flexible Extension Options

The new MicroAutoBox Embedded PC is modular in concept, so other embedded PC processors can be used as alternatives to the Intel Atom processor. The front panel of the Embedded PC provides three Gigabit Ethernet connectors, four USB 2.0 interfaces and a DVI-I output for transmitting video data. To give an example, touch screens can be connected to the overall system. The interfaces enable applications where it is neither desirable nor possible to take a notebook on a vehicle test, like on a motorbike. MicroAutoBox II with Embedded PC also has an internal PCIe MiniCard slot and an Express Card slot for integrating WLAN, mobile communications or FireWire. ■

Profile

Compact rapid prototyping system for real-time and PC applications

- Embedded controller for model-based function development
- Embedded PC for Windows/ Linux-based applications
- Remote control options for switching individual units on/off
- Complete compact, robust system
- Fan-free operation

Signals under Control

The powerful new Signal Editor

dSPACE's Signal Editor Module for the ControlDesk Next Generation experiment software is a new creative tool for ECU developers. This powerful add-on features extensive features for synthesizing, processing, and replaying signals.

Clarity and Speed, Please!

Developing and validating ECU software involves handling a vast number of incoming and outgoing signals, which all have to be measured for later analysis. For tests, recorded signals (e.g., from test drives) also have to be reproduced with the correct timing. In addition, synthetic signal behaviors, such as a preset sine behavior, need to be introduced into model parameters accurately. This form of signal generation is as important for HIL simulation as for RCP-based development. Keeping track of all the relevant signals, and being able to create or modify them quickly, is absolutely vital for an efficient workflow.
The Signal Editor Module for ControlDesk® Next Generation gives today's developers what they need: a convenient, creative, standard-compliant signal tool (ASAM AE HIL API 1.0) for a wide range of scenarios.

Extra-Large Signal Toolbox

Do you want to make a battery voltage drop to below 4 V for a period of 20 ms, reproducibly? Or repeatedly and reproducibly introduce error events with different ECU parameterizations during a drive on a virtual test track? The Signal Editor is just the toolbox you need, fully equipped for configuring, displaying and editing signals (signal addition and multiplication, loop, and so on). It also combines well with test automation tools like AutomationDesk®. With just a few mouse clicks, you can put signal

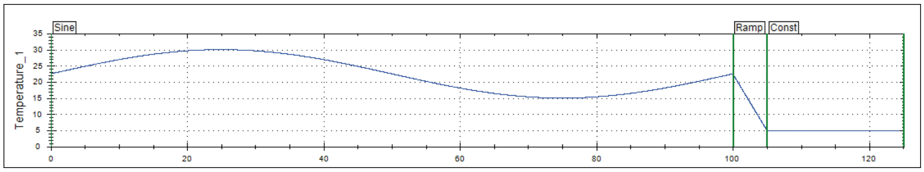


Figure 1: Representing temperature behaviors in the Signal Editor – here, a low-frequency sine between 15 °C and 30 °C followed by a sudden temperature drop to 5 °C.

segments together to create signal behaviors (Figure 1 shows an outside temperature with a low-frequency sine between 15 °C and 30 °C followed by a sudden temperature drop to 5 °C). The signal behaviors can be linked to conditions so that the abrupt drop in temperature is triggered by an event (such as driving into an underground garage).

Synthesis: Shaping Signals

The ability to create artificial signal behaviors is an indispensable part of building test scenarios. Real signals that can be used as a reference are not always available, and measured signals often have to be edited to make them suitable. The Signal Editor's synthesis features are a valuable help here. It has numerous basic signal types that you can base your definition on: sine, ramp, noise, and so on (Figure 2).
You can define time periods for the signals, design signal transitions, or quickly compute combinations of signal behaviors (by addition, multiplication, etc., see Figure 3). You can also combine synthetic signals with real measurements or imported data (to introduce noise on a measurement signal, for example). Dynamic dependencies can be defined for the signals: for example, a disturbance amplitude can be generated in proportion to a measured variable (such as vibrations proportional to vehicle speed). These signal behaviors are easy to introduce into test scenarios, as they are not integrated into the simulation model, but are added dynamically during run time with Real-Time Testing – a basic technology that has been a great success in AutomationDesk for many years now. The simulation model therefore remains independent of individual test cases. The supply voltage during engine startup is an example of a signal behavior that is required for a test. As the engine starts, the supply voltage signal has to indicate a brief drop in voltage. The HIL simulator sends the drop to the ECU, which then compensates for it.

Play It Again, ControlDesk!

When you want to replay measurement data (such as signals captured during a drive on a test track), you need a clear display and easy handling. The Signal Editor is the solution. Measurements recorded on a platform or device via ControlDesk Next Generation can be assigned to model parameters simply by drag & drop and then replayed. Recorded signals in MDF, MAT oder CSV format can be quickly imported via the measurement data pool. ECU optimization for a race car is one application which uses recorded measurement data. Formula One engineers have to cope with weekly software releases and numerous last-minute changes, because parameters have to be adapted to each individual race track. With the help of the Signal Editor, it is easy to assign the measured data (driving speed profile, gear change sequences, single wheel rotations, lambda values, etc.) to model variables, and to reuse the data for HIL tests on a test bench.

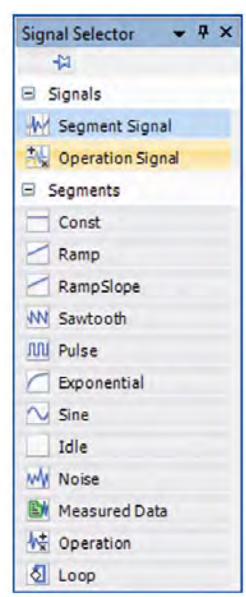


Figure 2: The Signal Selector is an easy way to select signal types.

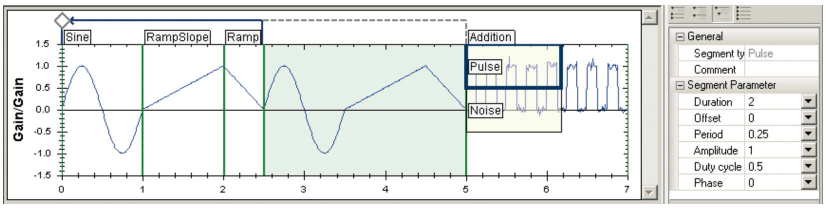


Figure 3: Signals can be put together from different segments and also combined (for example, by adding pulses or noise).

Faster with Automation

The Signal Editor Module in ControlDesk Next Generation can be closely coupled with the AutomationDesk test automation tool, especially for real-time tests. You can create stimulus signals in the Signal Editor Module, save them as STI files according to ASAM AE HIL API 1.0, import them into AutomationDesk and integrate them into test sequences together with signals from other sources. The tool coupling with AutomationDesk allows each signal to be used in different test runs and even varied automatically. For example, the frequency or amplitude can be increased stepwise in each new test run until a fault memory entry is made in the ECU. A measured signal can also be evaluated for compliance with predefined limits, which are described as reference signals in the Signal Editor and quickly made available in AutomationDesk for use with the evaluation library. The optional Signal Editor Module for ControlDesk Next Generation is the ideal companion for graphically defining signal behaviors and replaying them with correct timing on dSPACE hardware such as DS1005, DS1006, MicroAutoBox II and SCALEXIO. ■

Figure 4: Recorded signals can be used for HIL tests on a test bench, for example, for ECU optimization in Formula One vehicles.

Profile

Signal Editor Module
ControlDesk Next Generation

- Powerful editor for graphically defining stimulus signals
- Easy replay of measurement data, e.g., MDF
- Dynamic stimulus options, e.g., model-dependent signal changes
- Independent execution of several signal generators
- ASAM AE HIL API 1.0-compliant
- Signal exchange with AutomationDesk

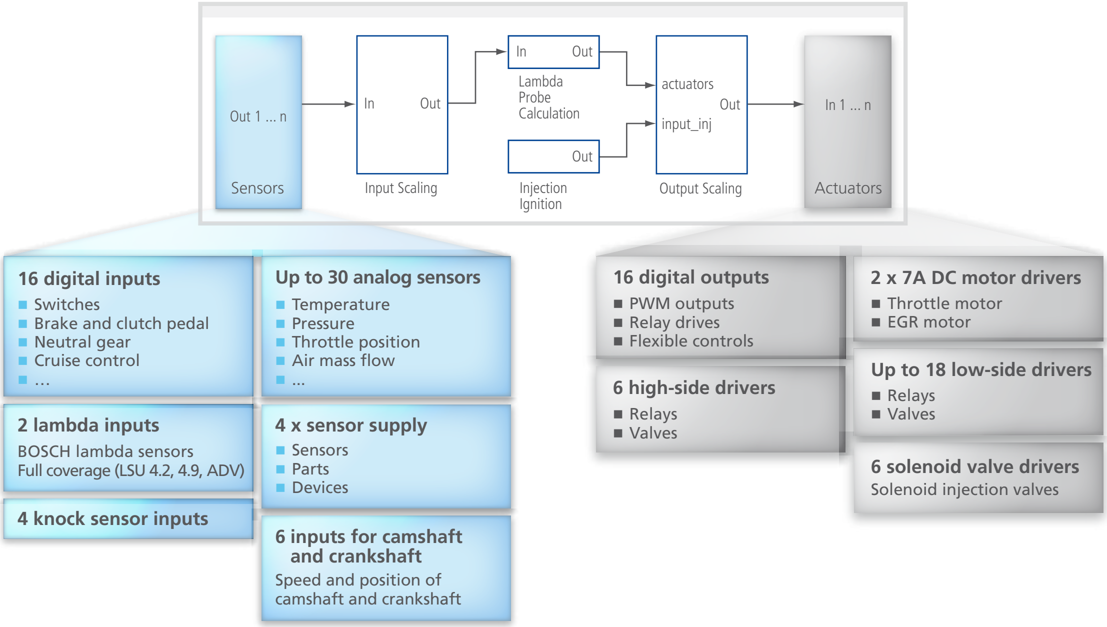
RapidPro: Fulfill objectives faster with new standard configurations

The Right System for Each Application

Speedy and convenient:
If you're developing an ECU for an electrified drivetrain, you can now use a preconfigured RapidPro system. dSPACE also provides optimum support for other application areas.

Compact and Vehicle-Capable

dSPACE's modular, compact RapidPro hardware provides signal conditioning and power stages for connecting automotive sensors and actuators to dSPACE prototyping systems. The RapidPro system is perfect for use in a vehicle, on a test bench, and in a laboratory. The RapidPro modules are easy to configure and there are numerous ways to combine them, providing the high flexibility necessary for handling changing



Developing new combustion processes is much easier with the engine control configurations for combustion engines with up to 6 cylinders. With the dSPACE Simulink® I/O model, developers can connect the sensors and actuators quickly and easily.

> Preconfigured yet flexible: The new configurations cover various applications and can be extended modularly.

project requirements. The result is that dSPACE customers neatly sidestep the expense of developing prototyping systems themselves.

Predefined Configurations

RapidPro's flexibly configurable hardware now has new companions: RapidPro standard configurations tailored to specific development tasks. These include classic tasks such as developing transmission controls and new tasks for current development trends, such as drivetrain electrification, and further optimization of the fuel consumption and emissions of combustion engines, to name but just a few. These predefined configurations are complete, tailored solutions that help users integrate sensors and actuators in their applications. The advantage: Developers do not need to set up and configure the system. They can concentrate completely on their core task, controller development.

The configurations cover current development areas in automotives:

- *Engine control configuration:* for combustion engines with up to six cylinders to develop new combustion processes, for example
- *Body electronics configuration:* for typical body electronics systems with a large number of digital inputs and outputs
- *Chassis control configuration:* for vehicle dynamics systems with connection options for typical sensors for acceleration, wheel speed, vehicle inclination, etc.
- *Transmission control configuration:* for new transmission functions with flexible power stages for valve or DC motor control
- *E-motor control configuration*: as a flexible power stage for a variety of electric motors in the prototyping phase

If a user's requirements are different from these ready-made configurations, the RapidPro system has the necessary flexibility for adaptations and extensions.

Preconfigured I/O Models

dSPACE also offers Simulink® I/O models designed specifically for the RapidPro standard configurations. These make preconfigured I/O signals available for the sensors and actuators to be connected.

Connect 4

Simulating Several Electric Motors with the DS1006 Quad-Core

When applications demand especially high processing power from a simulator, parallelization is often the answer. Hybrid drives are a typical example. A minimal model sampling rate is vital for simulating electric motors because it determines how precise and stable the engine control can be. This is the perfect playground for quad-core processors.

Applications and Advantages

When electric drives are simulated, the scenarios often require simultaneous calculation of several complex simulation models in real time. This includes hybrid drives, diesel-electric drives in commercial vehicles and locomotives, and path control of multi-axle drives in industrial machines. There are also applications in aeronautics, as when hydraulic actuators are replaced with electric motors.

Executing these computation-intensive simulations on one single processor board has many decisive advantages over using several boards:

- Higher bandwidth and lower latencies for communicating between models
- Flexible power reserves for further submodels to easily expand the simulator if necessary
- Attractive price/performance ratio

Quad-Power

The dSPACE DS1006 Processor Board with an AMD Opteron™ Quad-Core Processor (2.8 GHz) was designed exactly for this power range. Together with dSPACE's I/O solutions for electric motors, it supports the setup of hardware-in-the-loop (HIL) simulators that test the controllers of electric and hybrid drives. Each of the four cores can calculate a simulation model, so an internal combustion engine model and three electric engine models can be simulated simultaneously, or one internal-combustion engine model, two electric engine models, and a rest-bus simulation model or transmission model, and so on.

Communication between Processor Cores

The efficiency of the processor-internal communication is another vital factor, and high bandwidth and low latency are key. The cores of the

Signals for the Simulation
To test the ECUs of drive motors, it is usually sufficient to evaluate the signal level of the power electronics. To do so, the power electronics are removed, and only the signal processing portion of the ECU is connected to the simulator.

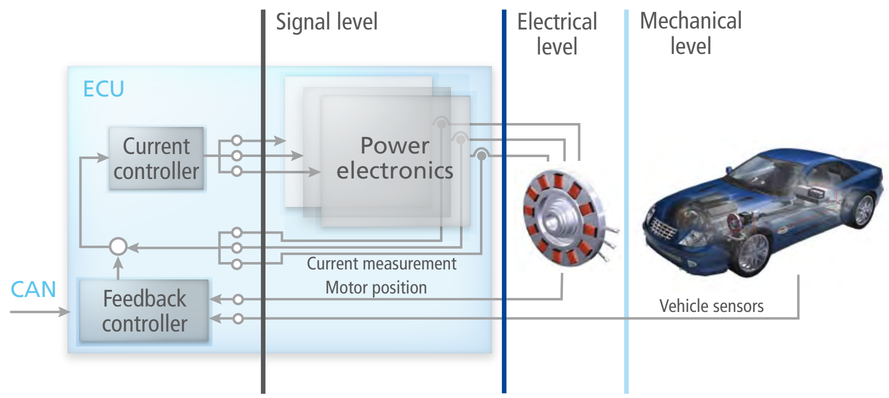


Figure 1: Interfaces for electric motor simulation.

quad-core DS1006 Processor Board communicate via virtual Gigalink connections. These have over 100 times the throughput and only a tenth of the latency of the optical Gigalink connections between the single-core DS1006 Processor Boards.

Graphical configuration for easily assigning models to the processor cores.

These figures apply to transfers of large data amounts between several cores of the quad-core processor on a quad-core DS1006. The figures are even better with smaller volumes of data.

Graphical Configuration with RTI-MP

The Real-Time Interface for Multiprocessor Systems (RTI-MP) software is used to configure the virtual Gigalink connection. In Simulink®, the blocks used for optical Gigalinks are the same as those used for virtual Gigalinks. This explains why the graphical representations of multicore and multiprocessor configurations are identical. This versatility simplifies the scaling of processing power and I/O performance. Existing RTI models for DS1006 boards can be reused easily with the new quad-core DS1006. Another advantage for scaling is the data throughput of the optical Gigalink connection, which is twice as high as that of the previous single-core DS1006.

Model Distribution and I/O Configuration

To fulfill the diverse test requirements for electric motors, the simulation models and I/O models can be distributed flexibly on the processor cores of the quad-core DS1006. Figure 2 shows a typical simulation model distribution and I/O distribution for testing hybrid drives. The first core calculates the model of the internal combustion engine. This is the main task of the multiprocessor (MP) model. The second core and third core execute the model (synchronous motor and inverter) and I/O access for the electric motor, respectively. The fourth core is free for further models, such as for simulating restbus communication. It can also execute the model and the I/O access of a third electric motor, for example, to simulate an auxiliary drive like a starter or a pump.

I/O Interfaces for Hybrid Drives

In the example shown in Figure 2, a dSPACE Electric Motor HIL (EMH) Solution is used for each electric motor. The EMH Solution is based on a dSPACE DS5202 FPGA Base Board and offers all the necessary I/O channels for simulating up to two electric motors. This includes outputting and measuring PWM signals and emulating the position sensor signals. The EMH Solution's I/O access is performed by the appropriate models on the 2nd and 3rd cores of the processor. The DS2211 HIL I/O Board covers the I/O requirements of the internal-combustion engine that is calculated on the first core of the processor. And there are separate PWM and PSS Solutions to cover especially extensive I/O requirements. These I/O boards were already been used with the quad-core DS1006 to develop a complete vehicle platform for solid models with a hybridized drivetrain.

Short Sample Times

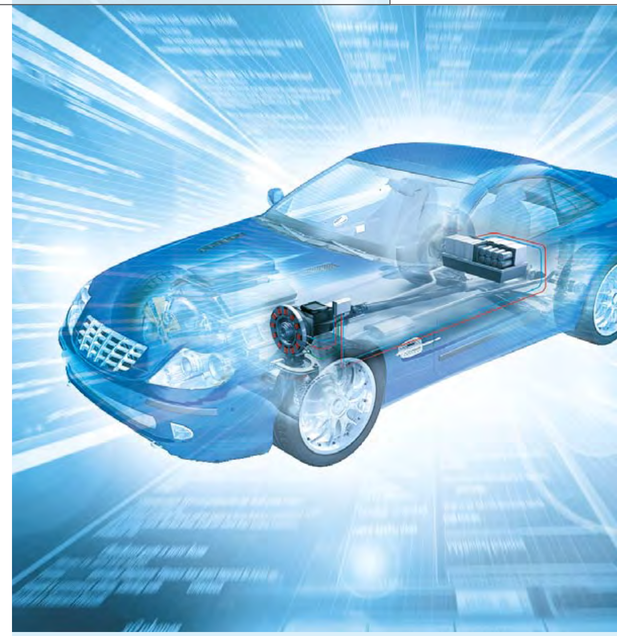
With the model distribution used in the hybrid example, the control loops of all simulated electric motors can still be calculated accurately at sample rates (PWM control frequencies) of 25 kHz. And there is still enough reserve capacity for handling additional I/O requirements and model requirements.

Precise Signal Measurement and Emulation

With a 3-phase PWM generated by the electronic control unit, the measurements of all the important control signal times for the power stages (duration of the PWM signal and the high- and low-side signals, and the dead time) are highly accurate. The measurements are carried out pulse-center-aligned to the PWM signals, with a resolution of 25 ns. The interrupts for the real-time model of the electric motor are also generated center-aligned to the control signals. The speed signals and position signals of the various analog (resolver, encoder) and digital (incremental encoder) sensor types are precisely simulated with a time resolution of 100 ns and 25 ns, respectively.

Summary

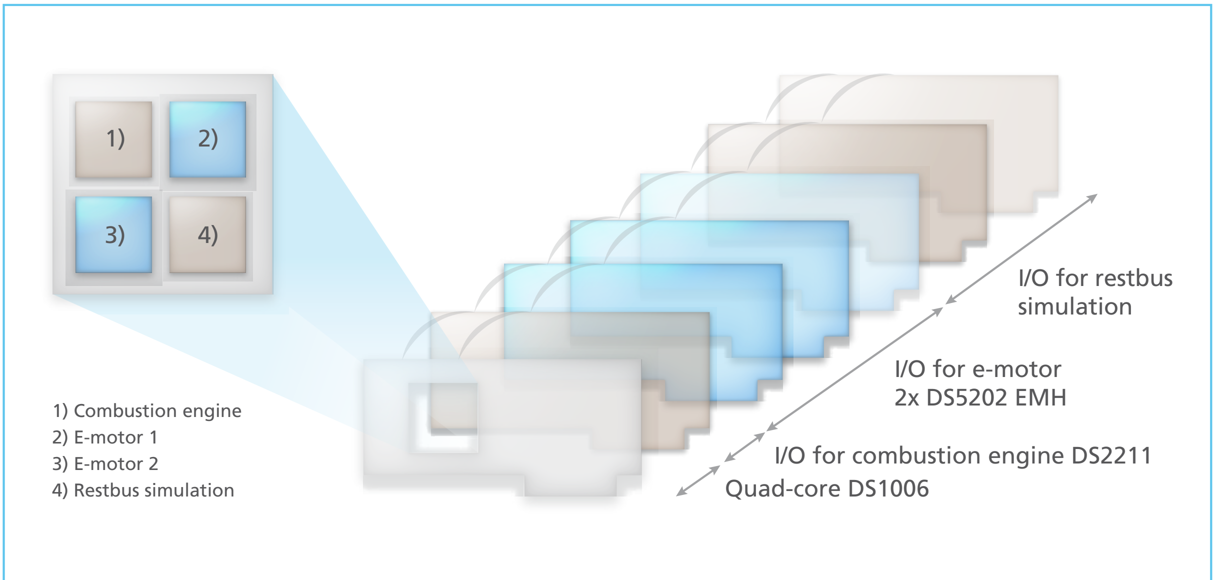
With the quad-core DS1006 Processor Board, equipped with an AMD Opteron™ Quad-Core Processor (2.8 GHz), up to three electric motors can be simulated to test electronic control units. This configuration is especially interesting for ECU tests of hybrid drives. The entire drivetrain can be simulated on a quad-core DS1006, including the models of the internal-combustion engine and the transmission. The signals necessary for carrying out simulations are made available via tailor-made I/O interfaces.

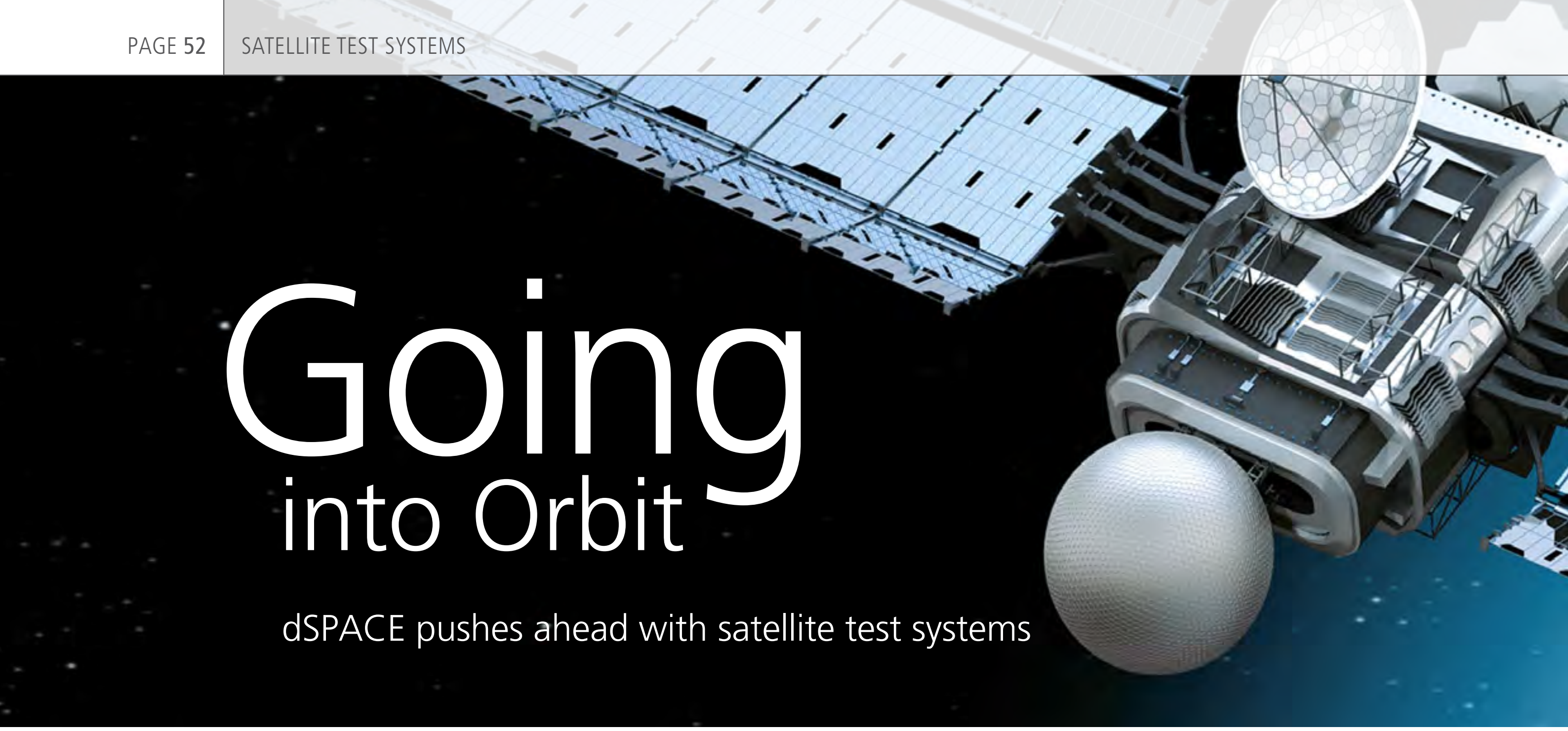


In Brief

- Precise real-time simulation of hybrid drives on one board
- Simultaneous simulation of up to three electric motors, including the internal-combustion engine model and transmission model
- High-performance I/O interfaces for electric motor signals

Figure 2: Each of the four processor cores of the quad-core DS1006 can calculate a model. With two electric motor models and an internal-combustion engine model, including the transmission, there is still one core available for restbus simulation or as a reserve core.





Going into Orbit

dSPACE pushes ahead with satellite test systems

The space industry makes extremely high demands on the development of electronic control systems. Business Development Manager Dr. Dirk Spenneberg explains how dSPACE's satellite technology solutions will help meet these demands.

Dr. Spenneberg, what does dSPACE aim to achieve in the field of space technology?

dSPACE systems are used in numerous space and aerospace applications. We're proud of this, and plan to extend our product range for these applications. Our main focus is on supporting acceptance tests for satellite subsystems such as attitude and orbit control or energy management, with the objective of strategic growth in these fields.

What makes these application fields so interesting?

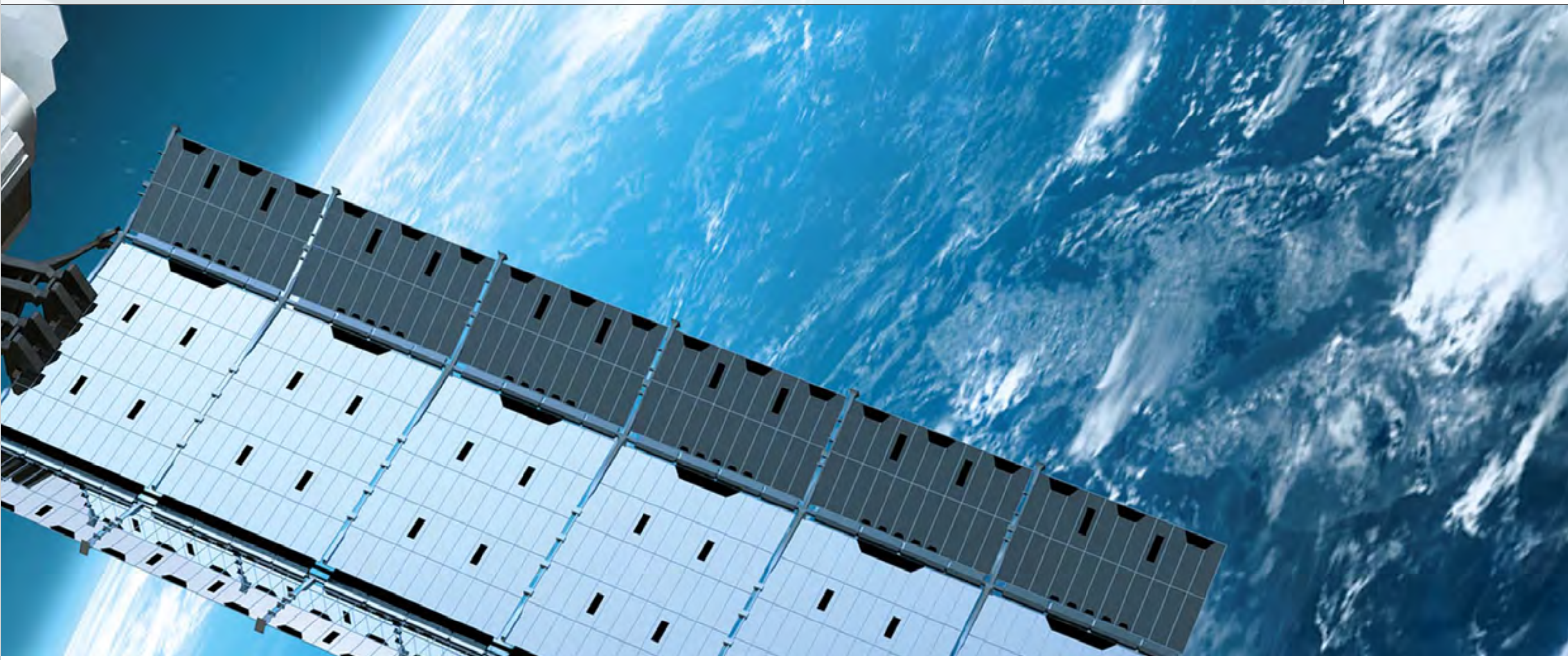
The attitude and orbit control system, or AOCS for short, is one of the most complex components in any modern satellite. For realistic simulation, all the factors that affect the satellite – even very small ones like solar wind – have to be modeled very precisely. In addition, numerous sensors (star trackers, magnetometers, etc.) and actuators (reaction wheels, magnetic coils, etc.) have to be integrated into the simulation.

Does dSPACE have the necessary know-how?

dSPACE has a mature tool chain to reliably test such complex systems with simulation support. Our hardware-in-the-loop (HIL) simulators are the de facto standard in the automotive industry and every day prove their ability to meet stiff challenges. Their operational track record is without doubt unmatched anywhere in the world. This is the solid base on which we can build solutions for customers in space technology. And to get additional expertise on board, we're proactively cooperating with institutions like the German Aerospace Center (DLR).

How are you going to convince your customers?

Whenever you enter a new field, the first steps are the ones that are the most difficult. Our systems are a good starting point, there is absolutely no doubt about that. In the USA, for example, we already gained customers such as NASA.
It is also clear that space technology has special requirements that we cannot fulfill yet. But we have an excellent track record on working side-by-side with customers, successfully tackling highly complex projects with numerous new requirements – and we also have a very proficient engineering department that quickly develops completely new solutions outside our regular product range. One example: the simulator for all the avionics in the Honda Business Jet.



> "As one of the largest providers of HIL systems, we can offer our space technology customers future-proof development tools."

Dr. Dirk Spenneberg, dSPACE GmbH

What kind of products are already under development?

In concrete terms, we are working on new simulation models for simulating a satellite on our HIL systems in real time, including AOCS-relevant sensor systems and all the environmental effects on the satellite. These models will comply with the ECSS standards and are also being validated by external experts. In parallel, we are extending our range of interface boards to provide optimum connections between space components and dSPACE systems. The MIL-STD-1553 Interface Board is a current example, and there will soon be a similar solution for the SpaceWire bus. For HIL tests, we will be able to supply turnkey systems with the usual high dSPACE quality.

Don't satellite manufacturers have their own models and simulators?

Simulation models are part of the core expertise of numerous companies. But they often need models from an independent partner. A dSPACE simulator is an economically attractive alternative to the special solutions that are widely used in the space industry – after all, we produce hundreds of our HIL simulators every year. Moreover, we are constantly updating our product portfolio to ensure that our technology is state-of-the-art. So space technology customers profit from high quality and a comprehensive tool range that are only possible because we're engaged in such a wide range of industries. As one of the largest providers of HIL systems, we can offer our space technology customers excellent sustainability.

Where do you go from here?

We're currently consulting closely with our customers and with experts from the DLR and the ESA to continuously expand our range. We would like to involve more people in this dialog, and invite any interested party to contact us and bring their new ideas and input to the table. We're not satisfied until our customers are satisfied.

Thank you for speaking with us, Dr. Spenneberg.

Profile

Dr. Dirk Spenneberg took over the management of Business Development for Satellite Test Systems at dSPACE GmbH in 2010. Before joining dSPACE, Dr. Spenneberg was responsible for the Space Robotics business field at the DFKI GmbH (German Research Center for Artificial Intelligence) in Bremen, Germany.

TargetLink Product Support Center

The TargetLink Product Support Center is a new web page that gives users easy access to all TargetLink information and utilities. This is just some of the information that the TargetLink Product Support Center provides:

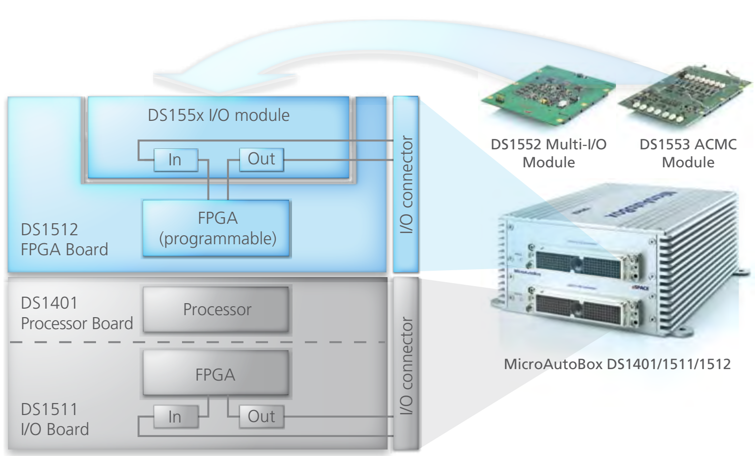
- On-demand TargetLink webinars
- Add-on tools such as TargetLink AUTOSAR Utilities and Data Dictionary Utilities
- Application notes and modeling guidelines for using TargetLink
- Information on TargetLink releases and compatibility
- TargetLink Known Problem Reports

You can access the TargetLink Product Support Center straight from the user interface of TargetLink 3.2 or via the following URL: www.dspace.com/TLPSC ■

MicroAutoBox II: New FPGA Technology

dSPACE Release 7.1 provides comprehensive support for the new MicroAutoBox II FPGA technology. The Spartan-6 FPGA integrated on the DS1512 FPGA Board can now be programmed in VHDL or by modeling in MATLAB®/Simulink®.

This gives users freedoms such as shifting computation-intensive signal processing algorithms to the FPGA to save resources. Also new is the DS1552 Multi-I/O Module, with powerful analog and digital I/O interfaces for connecting sensors and actuators to the FPGA. It is plugged onto the DS1512 FPGA I/O Board as the DS1552 piggyback module for complete integration into MicroAutoBox II.
Another special feature is that MicroAutoBox II can be extended with special I/O interfaces for specific application areas. For electric motors, dSPACE now also offers the AC Motor Control (ACMC) Solution for MicroAutoBox II. This is a complete package with hardware and software components (DS1553 I/O Module, RTI ACMC Blockset, Simulink demo models) that gets users off to a quick and easy start with prototyping electric drives.
In addition, dSPACE offers an engineering service for creating further customer-specific piggyback modules. ■



Availability limited outside of Europe and Asia.

Engineers in School

Students at Paderborn schools are enjoying physics lessons of a special kind. Not taught by their teacher, but by a dSPACE engineer. The students learn where and how a simulator is used, test a prototype vehicle, and even get behind the steering wheel on a virtual road – just like a computer game. The dSPACE engineer at the blackboard creates models and discusses the design of control systems with the class. What are longitudinal and lateral forces? What is brake slip? Where are the ABS components in a car? After just under two hours of formulas, drawings and simulations, the students know that once you have grasped the basics, mathematics and physics are no problem to use in practice. Engineers in School is just one of dSPACE's regular projects in the ProMINT® initiative. ProMINT stands for the promotion of Mathematics, Informatics, Natural Sciences, and Technology. dSPACE continuously offers internships to students, awards grants, and supports student project groups that investigate MINT topics. Why? Because dSPACE wants to proactively counteract the lack of engineers in Germany, and to get young people enthusiastic about the world of science. A total of more than 600 students in Paderborn have so far taken part in the Engineers in School program alone. dSPACE's Japanese subsidiary has also participated in numerous ProMINT activities. Foremost among these supporting student project groups and jointly holding real-world-based lectures at the University of Tokyo. ■

Benoît Vidalie, the New Head of dSPACE in France

Benoît Vidalie has taken over the reins of dSPACE Sarl, dSPACE's French subsidiary. He took up his new post in December 2010, and because he has previous experience at dSPACE and at a dSPACE distributor, he is optimally prepared for this new challenge. "With his dSPACE know-how and his professional experience, Benoît Vidalie has my complete confidence. I am certain that he will more than rise to this challenge. I'm looking forward to working with him again at dSPACE," comments Mirco Breitwisser, Director of Distribution Channels at dSPACE headquarters in Paderborn, Germany. "Together with my team, I want to extend dSPACE's position as the market leader for mechatronic development systems in France, and to meet our customers' requirements in the future," says the new French top manager.
Benoît Vidalie is replacing Salah Aksas, who was in charge of the company for 10 very successful years and is now moving on to tackle new tasks. ■

Please let us know your opinion on the quality of the dSPACE Magazine. Just fill out the enclosed reply card and return it to us. You can also use the card to order any other information by post.
Thank you!

You can also give us your feedback online. For further information, visit:
www.dspace.com/magazine

Release information on dSPACE products is available at:
www.dspace.com/releases