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dSPACE NEWS

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dSPACE NEWS

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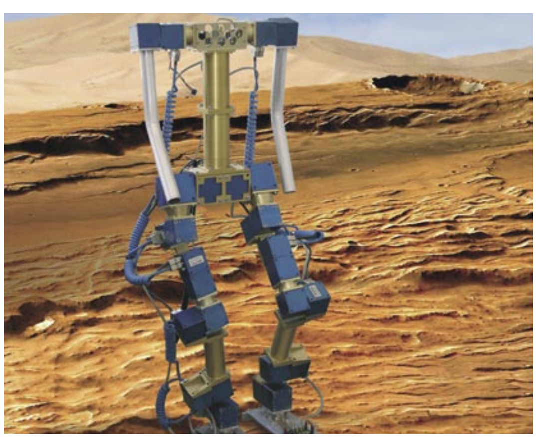
dspace-news@dspace.de · *info@dspace.de*
support@dspace.de · *www.dspace.com*

Project Manager and Author: André Klein
Technical Authors: Ralf Lieberwirth, Sonja Lillwitz, Julia Reinbach, Dr. Gerhard Reiß, Klaus Schreber
Co-Workers on this Issue: Dr. Herbert Hanselmann
Editors and Translators: Robert Bevington, Stefanie Bock, Louise Hackett, Christine Smith
Layout: Beate Eckert, Tanja Mazzamurro



12 *The University of Linz has been doing intensive research into bipedal walking for several years. A bipedal robot was developed using dSPACE hardware.*

14 *The Airbus A380 has a particularly complex system of slats and flaps. Airbus uses a multiprocessor system consisting of modular dSPACE hardware to test them.*

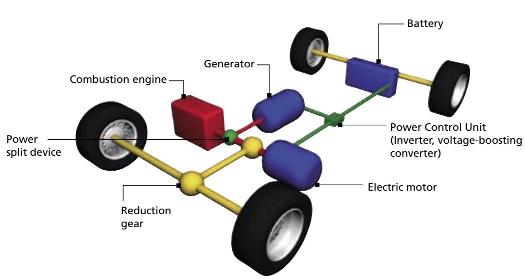
In my dSPACE NEWS editorials at the start of 2003 and 2004, I wrote how the automotive industry was cutting down on investments and how because of this, our own growth had slowed down compared with earlier years. Water under the bridge. Slow growth belongs to the past. We are back on our long-term trend. Demand increasing on all fronts. Perhaps partly due to the fact that we were simply stronger than the competition. But something else is also clear: OEMs and suppliers have realized they cannot stop the advance of electronics. And that if they did occasionally bring problems on themselves in the past by moving ahead too fast, those problems can be solved. Not least by good, reliable tool chains.

Hardware-in-the-loop simulators are being put to ever-increasing uses and once more showed particularly strong growth. Component suppliers could no longer withstand OEMs' pressure to invest more in testing, and some are even being told to use HIL in as many words. At the other end of the process, OEMs are using large integration test benches for verification. Individual component suppliers are breaking new ground, extending their testing capabilities beyond their own component test tasks. They want OEMs to see them as competent quality assurers who can see the big picture, capable of handling other components and domains than those they actually produce for.

From passenger vehicles, Formula One, and trucks, hardware-in-the-loop for dSPACE is expanding to include off-road and special-purpose vehicles. Interesting developments are taking place in these fields. And last but not least, there are the nonautomotive applications. Wherever we look, more work is needed on test methods and process integration. The approaches used today vary as widely as the customers themselves. There's a lot to do.

We doubtless have a good technical product basis for HIL. But that is not enough. Know-how in project planning and reliability in implementation are just as important. An HIL simulator is most valuable when it is used at an early stage. Our engineers have run so many simulator projects, they know how to go about it, and avoid having to look for errors in the simulator instead of in the object under test. Over and over again, customers have been surprised how fast they could start productive work. That also applies to dSPACE's other product fields. As shown by the fact that many customers opt for a dSPACE system even when their technical requirements are low and the performance of a dSPACE system is not absolutely necessary. What matters is that it works, and they can concentrate on the task in hand. And that they get fast, competent support if there is ever a problem. Feedback from our customers, much of it enthusiastic, shows that they get that support from dSPACE.

Dr. Herbert Hanselmann
President



16 *To simulate a hybrid drive, dSPACE uses special hardware for PWM measurement. A throughput time of 7 microseconds is achieved using the DS1005 PPC board.*

19 *Available from spring 2006, the new FlexRay tools makes it possible to integrate dSPACE hardware in a FlexRay communication network completely with dSPACE tools.*

Developing a Fully X-by-Wire Vehicle

- **Full x-by-wire fuel cell application featuring FlexRay and CAN**
- **GM uses several dSPACE MicroAutoBoxes for x-by-wire application**

FlexRay is a high-speed and fault-tolerant bus system for use in automotive applications. General Motors (GM) uses a FlexRay network to control the Sequel, a fully x-by-wire fuel cell vehicle. Several dSPACE MicroAutoBoxes with FlexRay and CAN interfaces form the distributed control system for the vehicle.

We developed Sequel as the next stage after Hy-Wire in the reinvention of the automobile, based on the AUTOnomy concept. It features x-by-wire in several control applications:

- 4-wheel steering
- Braking
- Propulsion/drive

Distributed Control System

The functions in the vehicle are controlled by a distributed control system. One challenge is to realize an x-by-wire vehicle which is as safe as a vehicle with mechanical brakes and drivetrain.

The control system consists of several dSPACE MicroAutoBoxes, linked by a DS830 MultiLink Panel from one host PC for master control, and integrates the multiple hardware platforms and software modules that were developed by different teams. Some model-based subsystems, for example, were developed by suppliers. The control system has FlexRay and multiple CAN busses. The MicroAutoBoxes have been equipped with FlexRay IP modules and act as host and gateway for the network. We used controllers, actuators, and sensors with dual/triple redundancy. We defined the process and interfaces for the models and control system, as well as the system naming conventions.

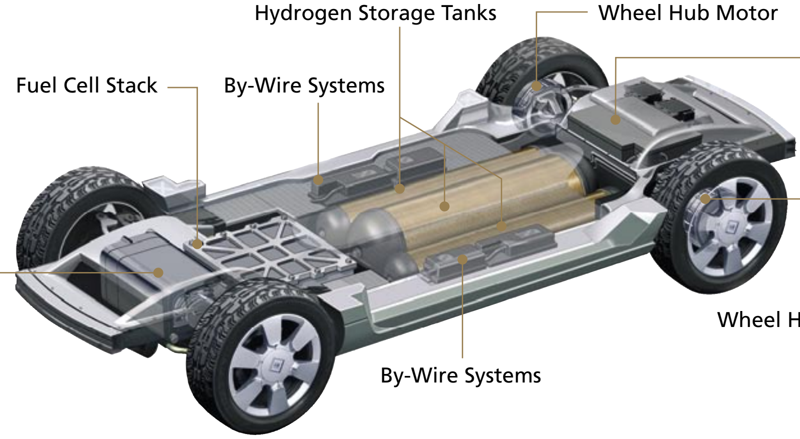
To implement the models on the control system, we used the RTI CAN Blockset and RTI FlexRay Blockset. Various third-party tools from DECOMSYS and Vector Informatik were also needed to set up the FlexRay and CAN environment.

Work Process

FlexRay requires an overall, agreed schedule, in which the following sequence of process steps is repeated:

- Developing physical and functional architecture
- Defining application task requirements and task schedules.
- Deriving communication tasks that create the communication schedule

The Sequel was modeled on the AUTOnomy show vehicle.



Improvements from Using FlexRay

Before FlexRay, all we could use was the CAN bus. A great disadvantage of CAN is that faulty nodes can bring down the whole network, because it is a nondeterministic protocol and has no redundancy. The overall benefits of using FlexRay are:

- Increased safety due to redundancy
- Higher performance due to better coordination between distributed controllers

The dSPACE tools worked as promised. Many other tools required much more effort on our part. The initial start up of the MicroAutoBoxes was very smooth and few problems were encountered.

▲ GM Sequel.

The FlexRay Challenge

The FlexRay concept is well thought-out. At first, tools for FlexRay were not very mature, which has been the biggest challenge, but this has greatly improved. To fully meet application requirements, integration methodologies had to be developed for FlexRay, and some software had to be integrated manually. Some manual work also had to be done to make all the tools work in the process.

Since we started the project, the FlexRay specifications and hardware have changed greatly. New releases fix minor problems and open up new possibilities.

FlexRay Consortium	
Foundation	September 2000
Aim	To develop a communication system for the tough requirements of future automotive applications, such as x-by-wire.
Role of General Motors	General Motors became a Core Member of the FlexRay Consortium in October 2001. With its experience in all areas of automotive research and developments, as well as its interest in the x-by-wire technology, GM helps to further develop the FlexRay standard.
GM about FlexRay	"FlexRay has many advantages to offer, such as fault tolerance and replicated dual channels for triple redundancy. This is especially important for safety-critical applications. FlexRay also supports high-performance computing and has a high communication bandwidth (10 Mbit/s). It is a time-triggered protocol for coordinated, distributed control systems throughout the vehicle."
Further information	www.flexray.com

Future Outlook

The future of FlexRay looks very promising – with smart actuators and fully distributed systems. FlexRay provides the right infrastructure, high bandwidth, fault tolerance, and determinism. Multiple CAN networks can be replaced by one FlexRay network. FlexRay offers increased safety, better performance, redundancy, and the ability to share more information. Initially the costs for FlexRay networks are higher, but as was the case with CAN, we expect that costs will drop to acceptable levels as the technology matures and volumes build up.

FlexRay is an enabler for the future to happen. It involves a process change for developers. FlexRay is time-triggered and we must think about the network architecture. We can't have both – a deterministic system and Plug & Play.

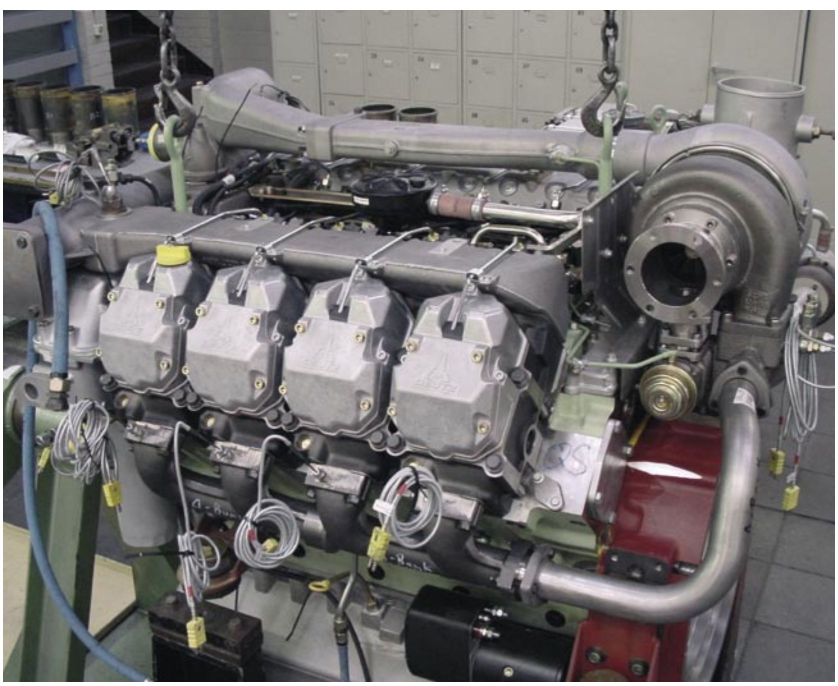
Sanjeev M. Naik,
Staff Research Engineer,
and Pradyumna K. Mishra,
Research Scientist
General Motors R&D Labs
USA

Dynamic Models for Deutz Diesel Power

- Deutz release tests for diesel engine ECUs
- HIL test system based on dSPACE Simulator and ASM Diesel Engine Simulation Package
- Fast variant handling by dynamic models

Deutz AG is relying on a test system based on dSPACE Simulator to run release tests on diesel engine electronic control units (ECUs). The hardware-in-the-loop (HIL) simulator works with the new ASM Diesel Engine Simulation Package. Optimum economy of the HIL test system was ensured by fast ECU variant handling and test automation. The model parameters can be accessed directly during run time for fast reparameterization, resulting in efficient ECU testing.

Engines from Deutz AG supply the segments for stationary and mobile machinery, agricultural technology, power generation, automotives, and marine technology. Products cover a broad range of 4-15 liter diesel engines with between 4 and 8 cylinders, and outputs from 64 to 500 kW. Some engines are also customized to meet requirements. The end result is an enormous number of engine variants and application versions in ECU software. The software is usually developed by the supplier of the engine ECU. As a rule, calibration and testing can be carried out on test benches and also in on-site trials. Deutz now supplement their testing procedures with hardware-in-the-loop (HIL) test systems



▲ *The Deutz TCD2015 V8 4V weighs approx. 1280 kg and has a maximum torque of 3050 Nm.*

Diesel Engine Model

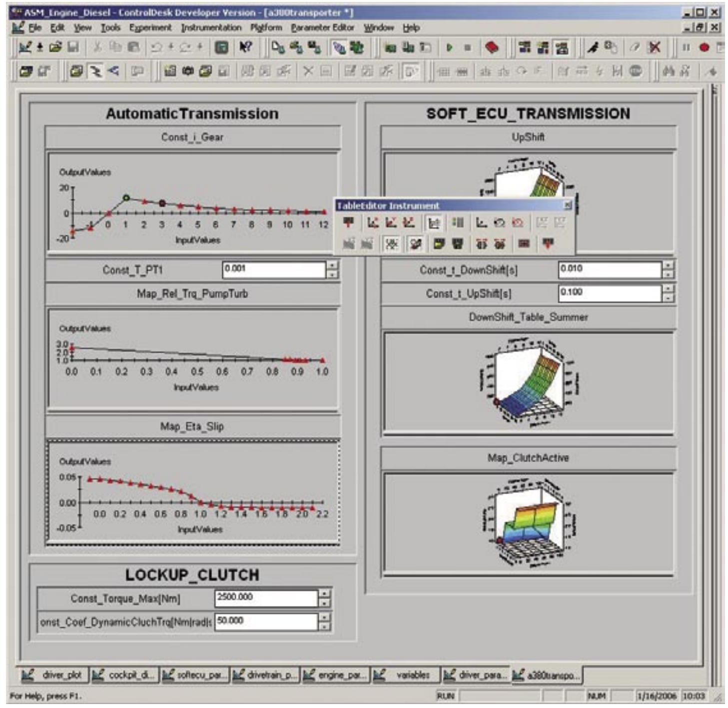
The Deutz HIL system can run four ECUs from different suppliers, including controllers for the pump-nozzle, pump-line-nozzle, and common-rail injection systems.

> *"With its flexible, fast configuration, the ASM Diesel Engine Model enables us to cover all our engine variants with a single model, and to switch back and forth between the variants very fast."*
> *Mark Zimmermann*

dSPACE developed an engine model which supports switching back and forth between the three injection systems, parameterization, and simulation.
The dSPACE ASM Diesel Engine Simulation Package contains not only the engine model, but also a transmission model and a simple vehicle dynamics model. All model parts are open, and can be extended easily and quickly to fit Deutz-specific engine variants. For example, the Viscotronic fan model with varying hysteresis curves, a rail pressure leak model with a mechanical pressure relief valve, and several different turbochargers were integrated into the model. In addition, the drivetrain model includes a test bench environment for simulating towing and sudden load variations as if they were on real test benches. This makes it possible to compare measurements on test bench engines with those from HIL simulation.

Preparameterizing the ECU Software

One special application for the HIL system is preparameterization of ECU software components that cannot be parameterized on the Deutz test benches (cruise control, fan, speed control). Preparameterization via HIL helps to ensure that on-site commissioning runs smoothly. One example is the aircraft tractor for the A380. A speed control had to be prepared and tested for this, holding a maximum speed of 25 km/h, both without load (50 t) and with full load (500 t). Because we could calibrate the model's parameters online, the following approach was sufficient to simulate operation with the aircraft attached, and ascertain the resulting acceleration, braking, and speed profiles: Using ControlDesk, the experiment software, the A380's starting weight of 500 tons is added to the tractor's mass of 50 tons. It is not necessary to reparameterize the model or to repeat code generation for it. The drivetrain components also have to be designed to achieve sufficient starting torque for this weight. This is easily done by selecting the characteristic of the torque converter and suitable transmission in ControlDesk. Testing the speed control in this way was enough to come to a qualifying decision on whether the software version is suitable for further study in the actual vehicle.



▲ *ControlDesk provides direct access to important model parameters during run time. The screenshot shows the transmission settings and the torque converter features.*

Test Automation

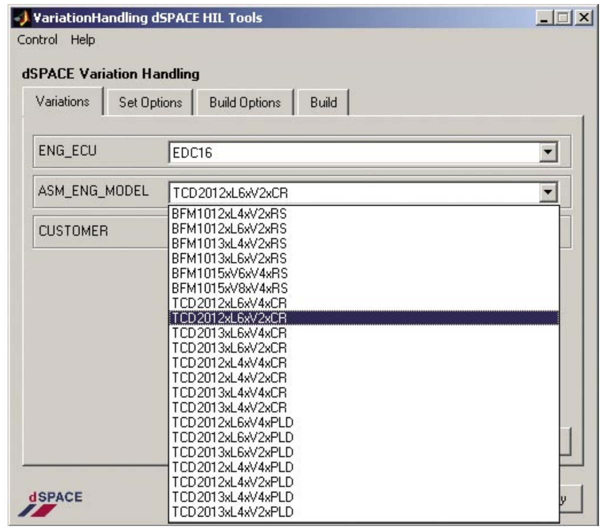
Deutz developed its own test automation system on the basis of dSPACE AutomationDesk. The individual automation steps are stored as Python scripts, and the test cases are parameterized via Excel reference lists. There are already about 1100 test cases, which run overnight for up to 11 hours. Test automation and model simulation processes have to be completely stable for this. Some test cases require particularly precise model behavior, so the model has to be generally of a very high quality. One example is a stable and stationary working point as a function of rail pressure, load, and loading air pressure, which in some test cases must not leave a tightly defined range.

Practical Benefits

The Deutz HIL system operates almost to capacity, and Deutz AG benefits greatly from obtaining test results quickly. The system's main areas of use are in the software development process and in the automatic release of various data sets. Test automation enabled us to immediately find errors in new software that had just been supplied – including errors which would have resulted in damage to a real engine. HIL tests have also prevented damage to real engines in the development of new data sets. Compared with a real test bench, the Deutz HIL simulator has the advantage that all the ECUs' inputs and outputs can be measured, and different engine variants, with

▲ *Specially developed for giants like the A380 Airbus, the towbarless AST-1X aircraft tractor from Goldhofer has two Deutz diesel engines.*

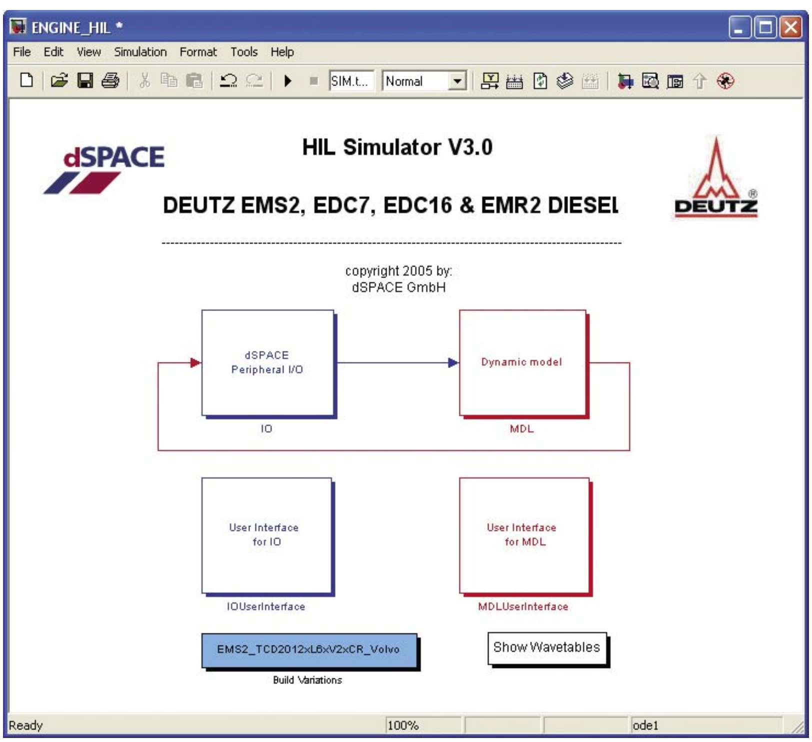
individual drivetrain characteristics, can be set. Moreover, the Deutz HIL system can simulate ideal load variations that would not be possible with the electrical test bench brakes. These are all optimum conditions for ECU testing. From the point of view of cost, an HIL simulator consumes only electricity, so several thousand liters of diesel are saved in the release process.



▲ *The variant management feature allows the 50 engine configurations to be switched in and out quickly and easily.*

Conclusion

dSPACE provided Deutz AG with a robust engine model. Easy-to-use engine variant management simplifies the handling of the approx. 50 engine models and customer applications. The interfaces to the model and to the hardware make it easy to interact with test automation. Test automation reduces the workload that would be needed for manual tests on new software. At current estimates, the 1100 reproducible test cases save 4 man weeks. Preparameterization via HIL improves and speeds up the commissioning of engines for on-site trials. HIL simulation has become a firm fixture in our release process for data sets and software. With its broad range of practical applications, the Deutz HIL system quickly proved its value.



▲ *The open ASM Diesel Engine Model can be viewed in Simulink, right down to block diagram level.*

Outlook

Deutz will increase the proportion of software tests run via test automation, to reduce the number of tests still performed manually. The data set release processes and new ECUs will be added to the test automation system. Deutz aims to extend and adapt the system for model-based bypass function development.

Mark Zimmermann
Development Engineer Engine Electronics
Electronics – Advance Development
Deutz AG
Germany

Glossary

Variant handling – Tool-supported process for switching between the parameter sets and configurations of the test system software

Calibration – Tuning the ECU software

Drive Safely with MTest

In the development of chassis control systems, complexity is increasing as development times decrease. BMW is therefore focussing strongly on verifying the systems at an early stage. MTest from dSPACE is a tool that allows extensive function tests to be performed efficiently on the Simulink® platform. During the production development of a shock absorber control, this verification level considerably enhanced the quality of the function logic, and therefore the efficiency of all downstream development steps such as code generation.

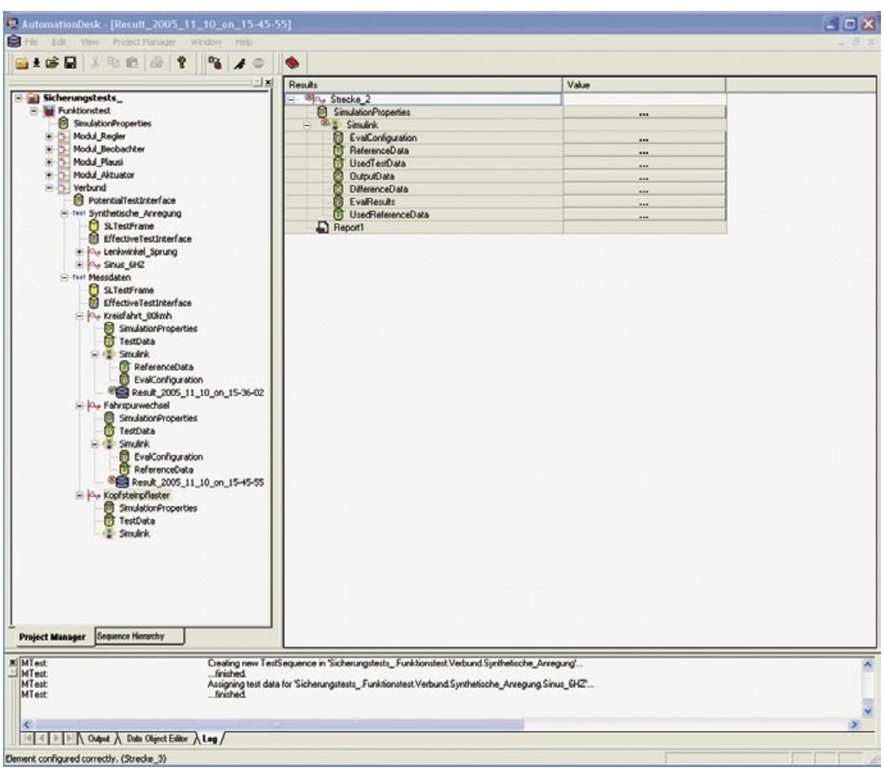
- BMW Group boosts efficiency with MTest
- Early verification in function development
- Electronic shock absorber control ensures vehicle dynamics and safety

Safety Versus Comfort? Problem Solved!

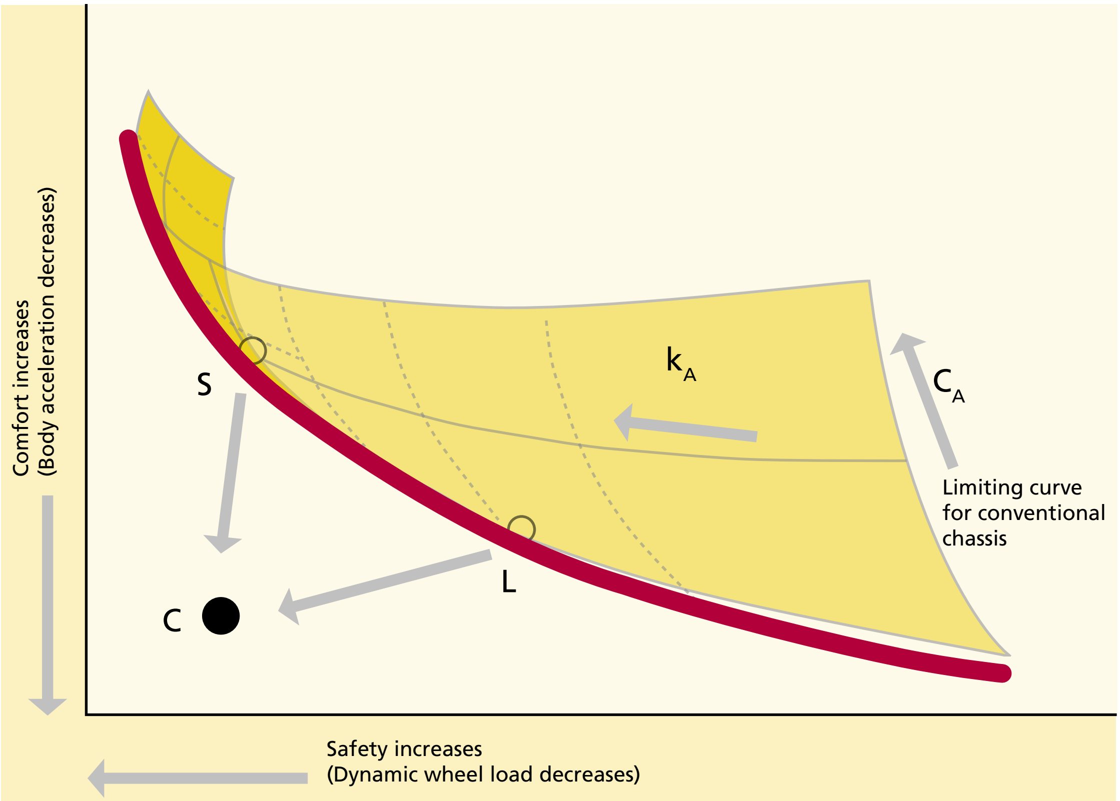
Safety and comfort are conflicting objectives in the design of conventional chassis. For a high level of comfort, the car body must be largely decoupled from road effects, while for a high level of safety, dynamic wheel load variations have to be minimized. These two requirements often run contrary to one another in the design of chassis components. An electronic shock absorber control has now considerably reconciled the two. It does this by adjusting optimum damping forces between the car body and the wheels according to the driving situation and the excitation coming from the road. The desired damping forces are computed from the variables for vertical vehicle movement and other data on the driving situation, for example, the steering wheel angle, by means of a control strategy.

Function Tests Reduce Error Propagation

A large number of small iteration loops are run through during the development of the control system, to achieve the greatest possible functionality and high reliability. This is done by making repeated functional modifications or extensions in Simulink and then converting these into ECU code by means of TargetLink. The iteration loops are error-prone, and must therefore be verified at the earliest possible stage to avoid error propagation and the unnecessary workload it involves. Moreover, the project has a fixed time schedule of integration stages,



◀ *The structure of the test trees makes test cases easier to view and use.*



Abbreviation	Description
L	Limousine with passive chassis
S	Sports car with passive chassis
C	Vehicle with controlled chassis
k_A	Damping constant
C_A	Spring constant

▲ *An electronic shock absorber control helps to achieve greater comfort and at the same time improves driving safety.*

each of which requires software that is completely verified if at all possible. However, all OEMs are under pressure to reduce the verification and testing times spent on cost-intensive prototypes, so to keep quality at the same high level, alternative methods are needed. One important step towards meeting these requirements is to verify the function logic in Simulink. This is called the executable specification. These tests are called function tests below. To run them, BMW looked for a test tool that would fulfil the following criteria:

- Support for the Simulink/TargetLink platform
- Options for tests on modules within the function model and for overall tests
- Realistic verification via specifications for sample time, excitation data from measurements, and all inputs
- Linking of specifications and test cases
- Black-box and white-box tests

MTest Used in Production Development

When BMW developed the software for the shock absorber control, it was the first time we had used the MTest tool from dSPACE in the production development process. One of MTest's great advantages is that it enables users to construct well organized test trees. The test trees currently consist of two test groups: In one group, individual models are selected from the overall system and tested for proper functioning (module tests). In the other, the overall system is verified in what are known as network tests. The aim is to test specific function modules from the overall system using appropriate test cases. Each test contains a large number of test sequences which address individual working points of the function under test, forming a tightly knit test net that will ideally detect all errors. Both generated stimuli and measurement data from various driving maneuvers are used as excitation for the test sequences. If a function is defined as error-free after a test run, its test results are used as a reference for all further test runs. In a subsequent test run, MTest evaluates the tests by comparing the test results with the references according to selected criteria. Another advantage of the tool is that it allows individual test sequences to be selected and executed if required, so it is not necessary to run through the complex test tree in its entirety every time. The tool also supports the automated execution of several selected tests, so extensive simulations can be run overnight and do not block computing capacity by day. To evaluate the tests, we use the Report Generator included in MTest. This shows test results graphically in a PDF document, which is then used for test evaluation.

> *"Using software tests can significantly increase efficiency in the development of complex vehicle control systems."*
> *Jan Kirschbaum*

Higher Function Quality with MTest

Verifying the executable specifications in Simulink increased the quality of the function logic quite noticeably and reduced the number of unnecessary iteration loops due to erroneous implementation. These tests played a major part in making BMW's development process even more efficient. MTest enabled us to handle the increased test requirement in developing vehicle control systems. However, further verification stages are needed to guarantee constantly high quality despite growing complexity. In future we will therefore increasingly need suites of tools that will support testing throughout the process and on all platforms. MTest's user-friendliness was further improved via good and constructive cooperation with dSPACE in the form of feedback session. Further optimizations will enable the tool to establish itself as a standart in this area.

Jan Kirschbaum
Vehicle Dynamics
Roll Stabilisation,
Engine Mounting System
Control Design
BMW Group, Munich
Germany

Andrea Neugebauer
Electric/Electronic Systems
Bertrandt GmbH, Munich
Germany

The Bipedal Robot

- The University of Linz is using dSPACE hardware to develop a bipedal robot
- Control by dSPACE DS1005 PPC Board
- Walking speed of 0.5 km/h

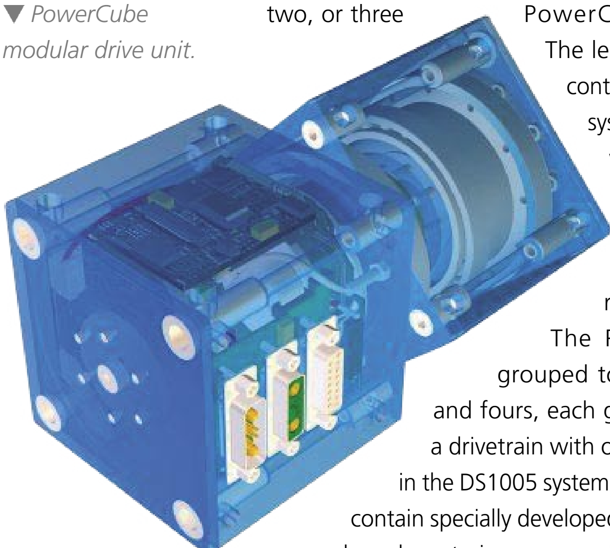
The University of Linz has been doing intensive research into bipedal walking for several years. The projects include developing new artificial legs and revolutionary drive concepts, and also a bipedal walking machine controlled by dSPACE hardware. The biped's joints are moved by DC motors with harmonic drive gears. The objective is to produce a completely autonomous robot.

Research into walking machines has increased greatly over the past few years. Walkers have the advantage over wheeled robots of being much better at maneuvering across rough and inaccessible terrain. Their potential uses include work in radioactive or chemically contaminated regions, which are extremely hazardous to human beings, and carrying loads on rescue expeditions in mountainous areas.

The Biped's Structure

The walking machine is 1.80 m tall and weighs 40 kg. It is driven by 14 PowerCubes from amtec robotics, a company in Berlin, Germany. These are compact rotary units consisting of electronic motors and play-free harmonic drive gears, with the entire electronics (control and drive) integrated. The biped was designed to mimic human gait. It has the same degrees of motional freedom as a human being, i.e., two directions of motion in the ankle, one in the knee, and three in each hip joint. Each joint therefore has one, two, or three PowerCubes in series. The legs are completely controlled by a DS1005 system from dSPACE, which communicates with the PowerCubes via a CAN bus at a rate of 500 kbit/s. The PowerCubes are grouped together in threes and fours, each group constituting a drivetrain with one CAN controller in the DS1005 system. The robot's ankles contain specially developed force-torque sensors based on strain gauges, which communicate with the dSPACE system via a microcontroller and an RS232 interface. The forces and torques are used to determine the zero moment point (ZMP), a parameter that is vital to stabilization. If the ZMP is within the foot area projection, the gait is stable.

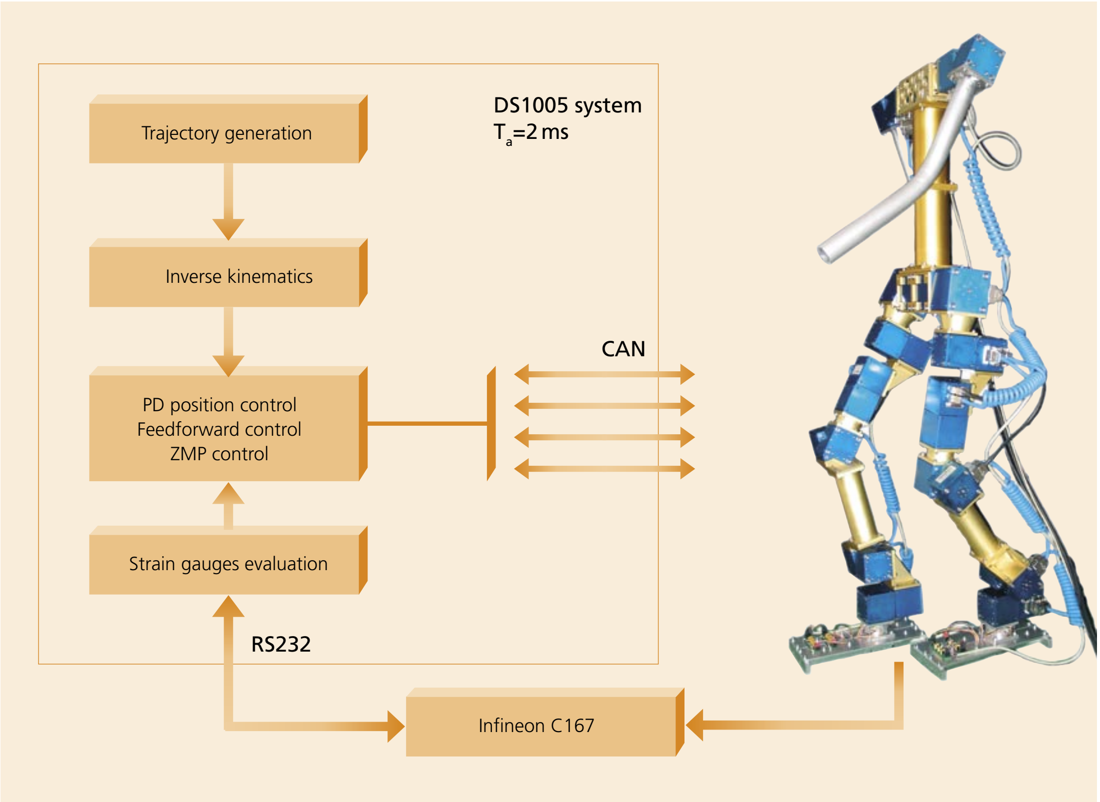
▼ *PowerCube modular drive unit.*



The Control Concept

The control was designed in MATLAB®/Simulink® and runs on the dSPACE real-time system. For maximum clarity of design, the sequence control was implemented as Statecharts in MATLAB/Simulink. All computations must be executed in real time.

- The control computations begin with the robot's current position and the direction in which it must move in 3-D space. The trajectory generator then uses this data to compute continuous trajectories for the hips and the two feet, expressed as positions in the inertial system and orientations in the form of Cardan angles. Calculation of the hip trajectories is based on an inverted pendulum, with an appropriate differential equation being solved to achieve a stable gait.
- The trajectories are available in world coordinates and converted into the biped's joint coordinates via inverse kinematics. Because of the way the legs are constructed, the inverse kinematics have no analytical solution and have to be solved numerically by Newton's method.
- The angles obtained from this are the input to the position control. This basically consists of a control with overlaid PD joint controllers. The control calculates the robot's entire forward dynamics during run time and compensates for gear elasticities. The PD control ensures that the joints are stable and equalizes factors such as imprecise parameterization and the effects of friction.



▲ *Schematic of the control concept: Communication between the dSPACE system and the force-torque sensors in the robot's ankles via a microcontroller and an RS232 interface.*

A ZMP controller is overlaid over the PD control to ensure stability of gait. The ZMP is given by the quotient of the relevant forces and torques in the ankles. The control system ensures that the ZMP stays within the convex hull of the foot areas.

High-Performance Real-Time System

All the calculations run at a sampling rate of 2 ms. The fact that the models are easy to modify has proven to be a decisive advantage. Our partners are two experts in the field of robotics, amtec robotics and dSPACE.

Outlook

The current implementation of the robot can reach a walking speed of 0.5 km/h. This speed will be increased in the coming months by extensions to the control concept. Additional sensors will also go into operation to scan the environment. The plan is to use two cameras that will perceive the three-dimensional environment in stereoscopic vision, enabling the robot to move autonomously.

Hubert Gattringer
Institute for Robotics
Johannes Kepler University of Linz
Austria

Glossary

Harmonic drive gear – Compact, lightweight transmission with a high gear ratio and high precision

Force-torque sensor – Sensor that evaluates the directions and amounts of effective forces and torques (for example, in the motion of a robot leg)

Zero moment point (ZMP) – Point at which all the forces and motion torques acting on the robot are zero

Trajectory – Computed path of motion

Airload Simulation on the Airbus A380

- Testing the Airbus A380's slat and flap control system
- Simulating real airloads
- Multiprocessor system of DS1005 PPC Boards

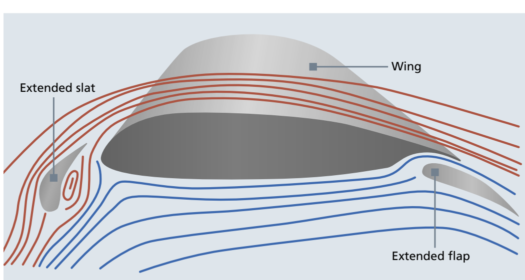
A system of movable slats and flaps enables commercial aircraft to increase the lift acting on their wings as required. This allows them to fly extremely slowly and especially facilitates take-off and landing. The largest passenger aircraft in the world, the Airbus A380, has a particularly complex system of slats and flaps. The Airbus test bench for this "high-lift" system uses a multiprocessor system consisting of DS1005 PPC Boards.

High Lift at Low Speed

A high-lift system consists of deflectable slats at the front of an aircraft wing and flaps at the back. The slats and flaps increase the curvature of the wings, which in turn increases lift. An aircraft with its flaps deployed can fly far more slowly at the same lift, which greatly reduces the length of take-off and landing runs.

The High-Lift Test Bench

The testing facility for the A380's high-lift components is Airbus's largest at its Bremen location. The entire system of slats and flaps, with all their drives, has been constructed in actual size. The control system for the facility was implemented by engineers from Ingenieurgemeinschaft IgH in Essen, Germany, who are experts in developing special test systems. The core task is precise control of the hydraulic and pneumatic cylinders that represent the varying aerodynamic airloads.



▲ *Schematic of the flow profile with deflected slats and flaps. Increasing the curvature also increases lift.*

In the slat test facility, a central hydraulic motor (5000 PSI) moves the slats via cardan shafts and drives. To simulate the airloads of a real aircraft, hydraulic cylinders on the drives generate the necessary compressive and tractive forces. The facility can exert forces of up to 600 kN (per wing half) on the slat system. The steel structure of the slat testing facility has dimensions to match: length 60 m, height 3.9 m, depth 4.5 m, weight around 50 tonnes.

▲ *The Airbus A380 during landing: Movable flaps and slaps on the wings increase lift and allow the aircraft to fly extremely slowly.*

The flap test facility also uses original components. A total of 46 pneumatic cylinders are in action, distributed across the surfaces. The facility can exert forces of up to 800 kN (per wing half) on the flap system. Again, the dimensions are impressive: length 34.8 m, height 7.2 m, depth 8 m, and weight around 155 tonnes.

Airload Simulation

In test runs, the flap positions are set by an original control from the actual cockpit of the A380. The flap/slat position determined via proximity switches is used to compute the flight phase and the highly dynamic current load situation that has to be controlled by the control system.

▲ *The high-lift test bench for testing the slat and flap system. The airloads of a real aircraft are simulated by hydraulic cylinders.*

The control system simulates the signal from the cockpit control in long-term trials. To do so, it includes a programmable sequence generator that enables various test cycles to be performed in any desired number of iterations.

> *"We're glad we used dSPACE in conjunction with MATLAB/Simulink. They give us the testing flexibility we need and enable us to adapt to new test scenarios in a minimum of time." Christian Tillmann, member of Airbus staff in the High Lift Test department (Bremen)*

The airloads are inserted via load value tables. These are provided in comma separated lists and transferred to the running system via a Python script that communicates with the dSPACE Real-Time Library (RTLib).

The Challenge of Complexity

The greatest challenge to implementing the control system is the structural complexity of the system to be controlled. More than 750 digital and analog input and output signals have to be processed, with clock rates of 500 or 1000 Hz. Some of these signals are wired directly, others are transported via PROFIBUS. The PROFIBUS is additionally used to continuously supply all the relevant data to an external logging system and to ensure continuous synchronization. The control system has other tasks to perform apart from simulating airloads:

It also regulates the supply of mineral oil to the test facility and the supply of hydraulic oil (Skydrol) to the drives on the aircraft side. All the functions of the control system are controlled via a graphical user interface that was set up in ControlDesk. The user interface was designed to provide the greatest possible flexibility in testing and give users all the information they need at any time and in a clearly structured form. The entire control system is based on two DS1005 PPC Boards, six DS2003 Multi-Channel A/D Boards, and two DS2001 High-Speed A/D Boards, which have to stand up to continuous operation.

Proven Under Load

The modular dSPACE hardware has proven very successful, as it has been in continuous operation for two years and up to the present moment shown no weaknesses. Developing control functions via MATLAB®/Simulink® has also proven useful. Finally, the competent support given should be emphasized, as it has been a great help, particularly for performing difficult subtasks.

Richard Hacker and
Dr.-Ing. Torsten Finke
Ingenieurgemeinschaft IgH, Essen
Germany

Twice the Power with Hybrid Drives

- HIL simulation of a hybrid drive
- Special hardware for PWM measurement
- Throughput time 7 microseconds

Soaring fuel prices and tougher emission guidelines are presenting automobile manufacturers with new challenges. For many of them, the hybrid electric vehicle (HEV) is the answer to both problems. Combining a combustion engine with an electric motor reduces fuel consumption and toxic emissions, and at the same time makes driving more fun. Interest in this alternative form of propulsion is growing, especially in Asia and the USA. To test the electronic control units (ECU) for the hybrid drive, special dSPACE boards are used in hardware-in-the-loop (HIL) simulation, drawing on dSPACE's years of experience in simulating electric drives.

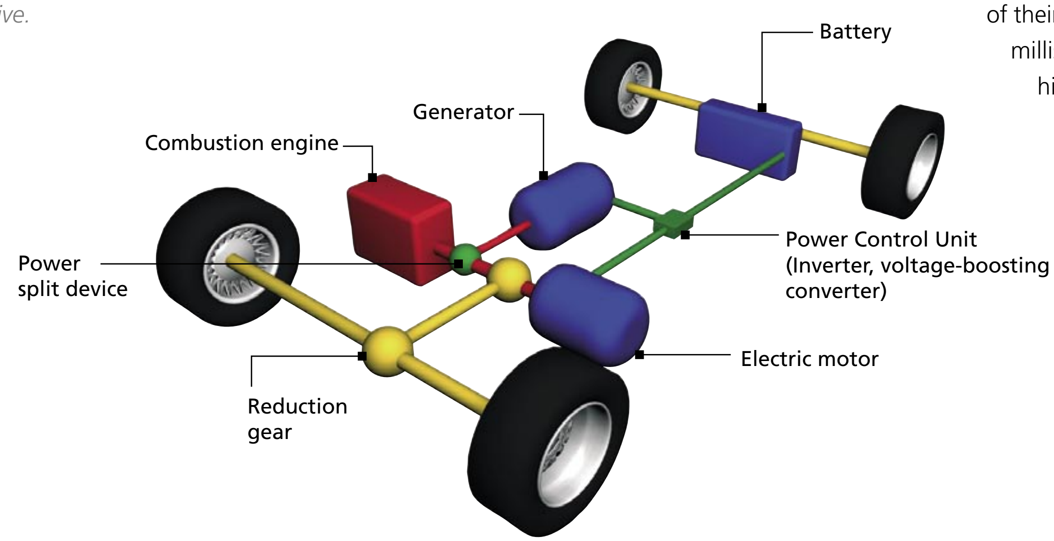
Hybrid Drives in Brief

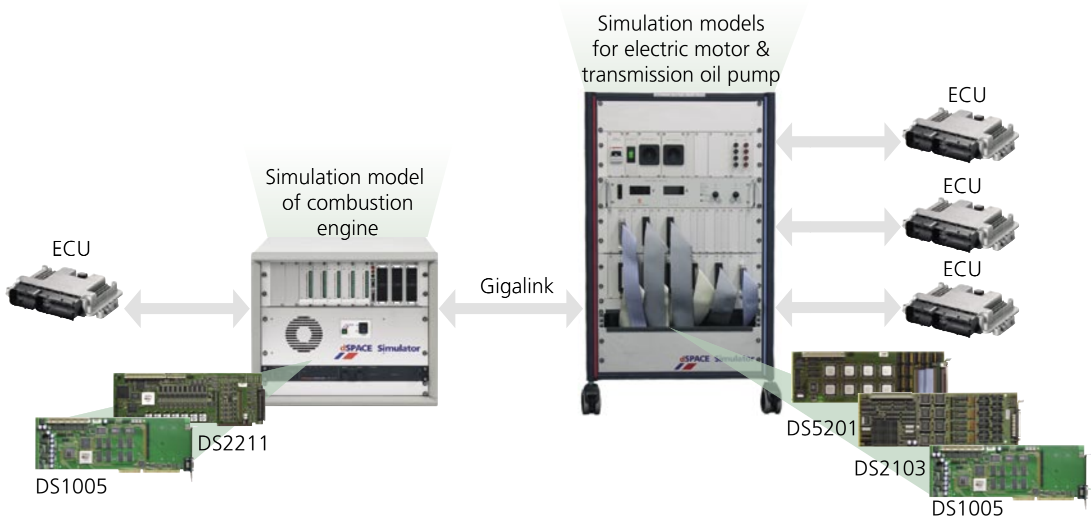
Most vehicles with hybrid drives combine a combustion engine with one or more electric motors to utilize the strengths of both kinds of drive. An electric motor has the advantage of being able to accelerate straight from zero to a very high torque. When the vehicle brakes, and while the combustion engine is running, the electric motor functions as a generator and recharges the battery. A combustion engine usually has good efficiency only in a restricted engine speed range. The interaction between the two different systems results in high torque across a very large engine speed range, which additionally reduces fuel consumption and toxic emissions. The combustion engine in HEVs delivers the necessary propelling force for high-speed driving on the open road, and the electric motor provides additional drive torque during the acceleration phase. In town, where starting and braking alternate constantly, the vehicle automatically switches over to the electric motor, which is supplied by the battery.

Hardware-in-the-Loop Simulation

One typical customer application is simulation of a combined combustion engine and electric motor to represent the longitudinal dynamics of a hybrid drive. The two torques, one for each drive, are computed from the ECU signals and then coupled via a transmission model to form a single drive torque. This loose form of coupling has the advantage that the submodels are computed in separate tasks, so that real-time conditions can be achieved for each ECU independently. Electric motors act much faster than conventional combustion engines and can reach 90% of their maximum torque in only a few milliseconds, which requires a very high sampling rate. Thus, typical ECUs for electric machines have cycle times of approx. 60 to 200 microseconds. The throughput time for simulating an electric motor and its associated I/O signals on a DS1005 PPC Board is usually 7 microseconds.

▼ Combustion engine and electric motor can work separately or together in this hybrid drive.





▲ *Custom setup of dSPACE simulators for simulating the combustion engine and electric motor.*

This speed is achieved in conjunction with components such as the DS5201 IGBT Pulse Measurement Board (IGBT = insulated gate bipolar transistor), which has been optimized for this application area. This measures the PWM control signals (PWM = pulse width modulation) of the electric machines with a resolution of 25 nanoseconds. It has over 64 channels, on which parallel input signals can be measured and evaluated by means of a field-programmable gate array (FPGA). The motor angle and the required current are determined in the electric motor model and fed back to the ECUs via the DS2103 Multi-Channel D/A Board. Unlike the simulators for combustion engines, the electric motor simulators do not fetch the signals from the actual connections to the drive electronics, but instead, the control loop is closed via the control signal of the power electronics. In future, it will be possible to map 3-phase electric motors for further processing by simulating inductive loads. The inductive loads will be represented by special motor load simulation hardware with an integrated analog processor. The simulation of electric drives will then no longer be restricted to automotive applications, see also dSPACE NEWS, Fall 1997.

A Typical Customer Project

One specific customer project involved constructing a multiprocessor system in which two simulators were linked. The first simulates the combustion engine and the transmission on a DS1005 PPC Board. The necessary inputs and outputs are provided by a DS2211 HIL I/O Board with integrated signal conditioning (at a sampling rate of 1 millisecond). The second simulator computes the electric components of the hybrid drive. These consist of the simulation models for two electric motors and one electrically driven transmission oil pump. The ECUs of the electric motor have a cycle time of 125 microseconds, so with a throughput time of 7 microseconds, it is no problem to compute all the electric machines on one processor board. The electric motors concerned are permanently excited synchronous machines (PSMs). They interact in a complex manner, coordinated by the drive management feature. In this system too, the simulation systems of the combustion engine and of the electric motor are coupled by computing the resulting total drive torque.

Glossary

IGBT – Semiconductor component used in power electronics.

FPGA – Freely programmable logic circuits.

Gigalink – High-speed serial data transmission via fiber-optic cable and 1.25 Gbit/s technology.

Easy Handling for CAN Networks

- Simulating complex CAN networks
- Flexible manipulation at message and signal levels
- Restbus simulation for testing individual ECUs

With the extent of networking between electronic control units (ECUs) in today's vehicles, simulating the bus communication in hardware-in-the-loop (HIL) systems is indispensable. Simulation of a CAN network bus can be configured centrally in Database for CAN (DBC) files via the RTI CAN MultiMessage Blockset. This makes the complexity of bus communication, and the frequency with which it is modified, much easier to handle.

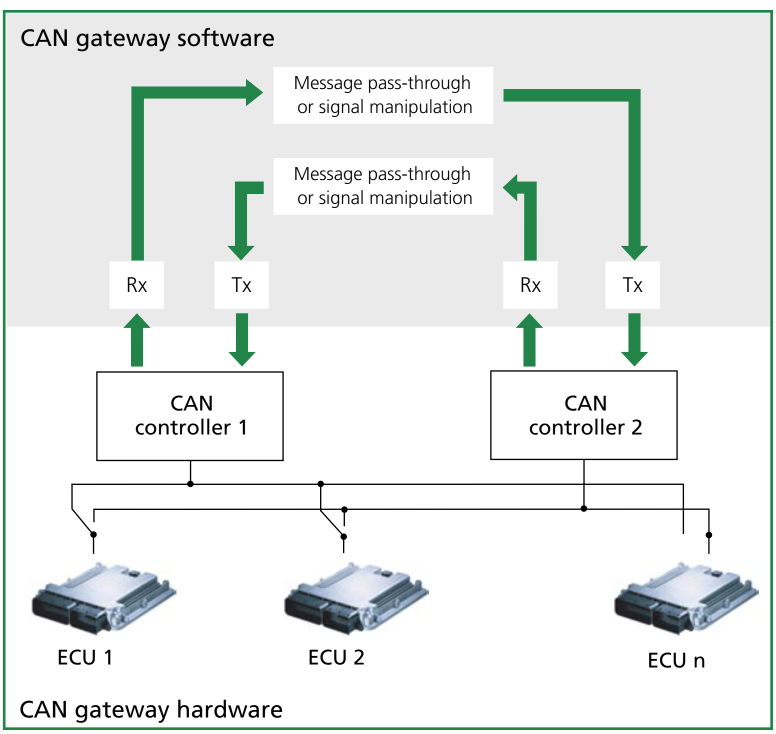
The RTI CAN MultiMessage Blockset lets you configure and manage more than 200 CAN messages with a single Simulink® block. This reduces the model size of HIL systems via complex CAN setups, and speeds up both code generation and compilation.

Restbus Simulation

Tests can be run to stimulate errors and check whether an ECU detects them, using the blockset to generate messages containing special signals such as:

- Counter or mode signals for detecting faulty nodes in the CAN network
- Checksums or parity bits for detecting transmission errors and unauthorized transmitters

For plausibility checks in the ECU on other variables with model relevance, the messages also consist of synthetic signals or of signals from the real-time model.



▲ *The gateway concept: dSPACE Simulator functions as an error gateway between the ECUs.*

The Gateway Concept

Error gateways have proved a useful method of signal manipulation in a HIL simulator with several bus nodes. The bus lines of an ECU are switched to an "error bus" in the simulator, which manipulates messages as required and transmits them via the original CAN bus or the "error bus". Changes to individual CAN signals (such as checksums), entire messages (absence, wrong timing), and even the complete failure of an ECU can be simulated, and their effect on the rest of the network investigated. Messages from ECUs that are not present in reality can also be generated.

Online Manipulation

The blockset provides a wide range of options for targeted manipulation of bus communication online. This makes it easy to create widely varying test cases. For example, the value for each signal in the messages to be transmitted can be specified methodically. Special signal generation can also be corrupted for a specific number of transmission times for one message. Entire messages can be suppressed for a defined number of transmission times, and additional messages can be sent. These options are also available for automated tests on the ECUs.

Working with FlexRay

The first vehicles to use FlexRay, the standard for a new generation of powerful, deterministic communication networks, will roll off the production line in 2006. dSPACE had solutions for developing FlexRay-based software for electronic control units (ECU) at a very early stage, and plans systematic further development in this field.

- New blockset integrates dSPACE hardware into FlexRay communication networks
- Configuration tool for efficient preparation of FlexRay simulations

dSPACE Products in Use

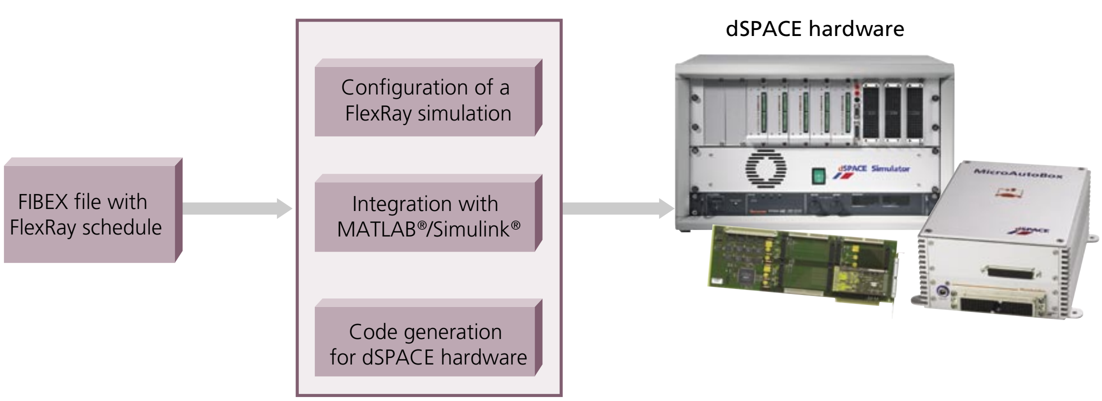
The BMW Group's use of FlexRay was described in the first 2005 issue of dSPACE NEWS. Other companies such as General Motors (p. 4-5) are also relying on products from dSPACE to verify the new protocol and develop innovative FlexRay applications.

FlexRay Development

The production applications that are planned make tough demands on the requisite development systems. To serve the increasing number of FlexRay ECUs, central message catalogs are coming to the forefront. The new requirements will govern the development of individual vehicle functions, and the verification of both single and networked FlexRay ECUs.
dSPACE's proven-in-use products for CAN communication (p. 18) are now joined by a wide range of constantly evolving FlexRay products.

New RTI FlexRay Configuration Blockset

In response to customers' requests, dSPACE will be offering an RTI FlexRay Configuration Blockset and configuration tool (single source) from early 2006, to optimize tool use in the development of FlexRay applications. This will mean that dSPACE systems can be completely integrated into FlexRay communication networks by means of dSPACE tools. Both rapid control prototyping tasks and tests on FlexRay ECUs, including restbus simulation, will be supported in this way. Familiar features of dSPACE products can be applied to the FlexRay bus. The blockset supports not only model-based work, but also integration into other dSPACE tools for experiments, visualization, and tests. Synchronous data recording for dSPACE processing nodes will be supported by an extension to dSPACE's experiment software, ControlDesk. The use of ASAM MCD-2FBX (FIBEX) for importing FlexRay schedules is also in preparation.



▲ *Configuring a FlexRay application with the RTI FlexRay Configuration Blockset, from setting up the FlexRay schedule to implementing it on the dSPACE hardware.*

ECU Diagnostics with CalDesk

- Measurement, calibration, and diagnostics with CalDesk
- ODX support
- Fault memory, diagnostic services, Java jobs, flash programming

Version 1.3 of the CalDesk measurement and calibration software has an additional software module for diagnostics on electronic control units (ECUs): the CalDesk ECU Diagnostics Module. Users now need only one single tool to perform measurement, calibration, and diagnostics tasks. The core functionalities of the ECU Diagnostics Module are reading and resetting the fault memory, executing diagnostic services and Java jobs, and flash-programming ECUs. The diagnostic support provided by CalDesk is completely based on the ASAM standard ODX.

Measurement, Calibration, and Diagnostics with a Single Tool

Currently, often two tools are required for calibrating software parts that are relevant to diagnostics: one for measurement and calibration, the other for diagnostic tasks. This frequently involves complex setups containing twice the amount of hardware.
As regards standards, the established standard for measurement and calibration is ASAP2 (ASAM-MCD 2MC). For diagnostics, the ODX standard is gaining in importance. It will close the gap between the two types of tool, paving the way towards generic tools for measurement, calibration, and diagnostics (or MCD tools for short) that are completely based on standards. These have obvious advantages:

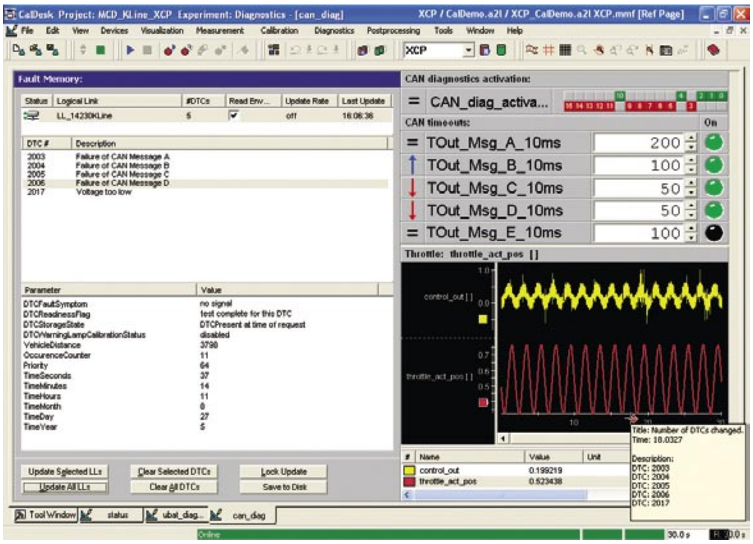
- Universally applicable to different ECU projects – completely standard-based
- Time and cost saved – users need to learn only one tool
- The same interface hardware for measurement, calibration, and diagnostics – saving costs and simplifying hardware setups
- Greater convenience: parameter tuning and fault memory evaluation with a single tool, for example – so diagnostic functions are easy to calibrate
- Measurement, calibration, and diagnostic data are time-correlated and stored together

In close consultation with an automotive lead customer, ODX-based diagnostic support is being added to the CalDesk measurement and calibration software to create a generic MCD tool. (For details of the release date for the ECU Diagnostics Module as part of CalDesk 1.3, see *www.dspace.com/goto?releases)*.

The ASAM Standard ODX

Open Diagnostic Data Exchange (ODX) is the ASAM-MCD 2D V2.0 diagnostics standard, providing an open diagnostic data exchange format throughout the entire vehicle lifecycle. During the development phase, ODX and ASAP2 (ASAM-MCD 2MC) together describe the capabilities of an ECU with regard to measurement, calibration, and diagnostics. ODX describes communication with ECUs via diagnostic interfaces, covering points such as:

- Vehicle topology and access paths to an ECU
- Diagnostic protocols and communication parameters
- Services of the protocols, such as reading the fault memory
- Data of the protocols, such as the ECU's fault memory entries and logical identifiers for ECU variables
- Specifications for ECU flash programming
- Java jobs for controlling specific diagnostic sequences such as recurring complex tasks and flash sequences, using the available diagnostic services



▲ *Measurement, calibration, and diagnostics in CalDesk – shown here with the Fault Memory instrument. The measurement comment in the plotter indicates a change to the fault memory entries.*

Seamless Integration into CalDesk

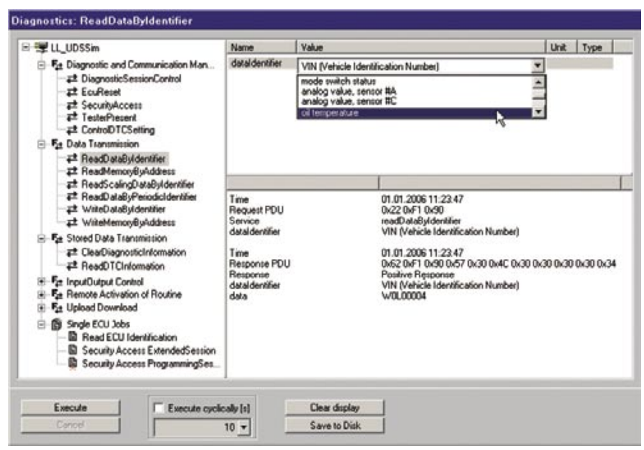
The ECU Diagnostics Module has two instruments, the Fault Memory instrument and the Diagnostics instrument. These can be combined with CalDesk's other instruments in any way required. ECU flash programming can also be performed directly from CalDesk. ECU access is performed via the diagnostics standards KWP2000 on CAN or K-line (ISO15765/ ISO14230) and UDS (Unified Diagnostic Services, ISO14229). The existing dSPACE CAN hardware, such as DCI-CAN1, the USB-to-CAN Converter, can be reused for CAN-based diagnostic access, and also shared by measurement, calibration, and diagnostics tasks. If the CalDesk Automation Module is used, the ECU can be accessed via the ASAM-MCD 3D automation interface, for example, for test automation or test bench tasks.

Fault Memory Instrument

The Fault Memory instrument displays the fault memory contents for one or more ECUs. This can be updated manually, or automatically at regular intervals. It also lets you delete individual entries or clear the entire fault memory. The fault memory contents can be saved in ASCII or XML format. Users often need to know not only whether a fault memory entry occurred, but also when. CalDesk provides a means of recording these events. Every time a fault memory entry occurs, a bookmark is automatically inserted into the ongoing measurement and saved together with the measurement and parameter values.

Diagnostics Instrument

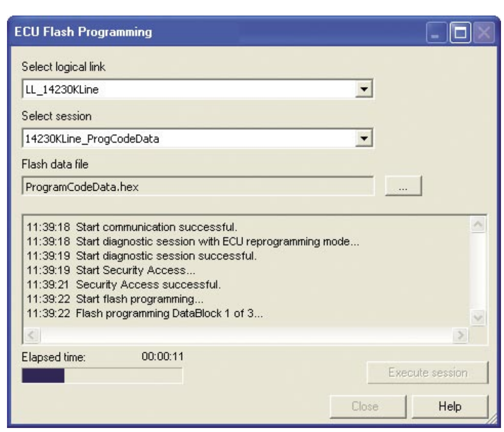
The Diagnostics instrument allows direct communication with the ECU via the diagnostic protocol. It includes a structured, configurable display of the available diagnostic services and Java jobs from the ODX database. Jobs describe predefined sequences, which can include the ECU's elementary diagnostic services, and are quick and easy to use, even with no in-depth knowledge of diagnostics. Users select a service or job and then parameterize or execute it.



▼ *The diagnostics instrument for flexible communication with the ECU via the diagnostic interface.*

ECU Flash Programming

New software updates and data sets can be flashed quickly and easily. The user simply selects one of the flash sessions defined in the ODX database and starts execution – a "push-button solution".

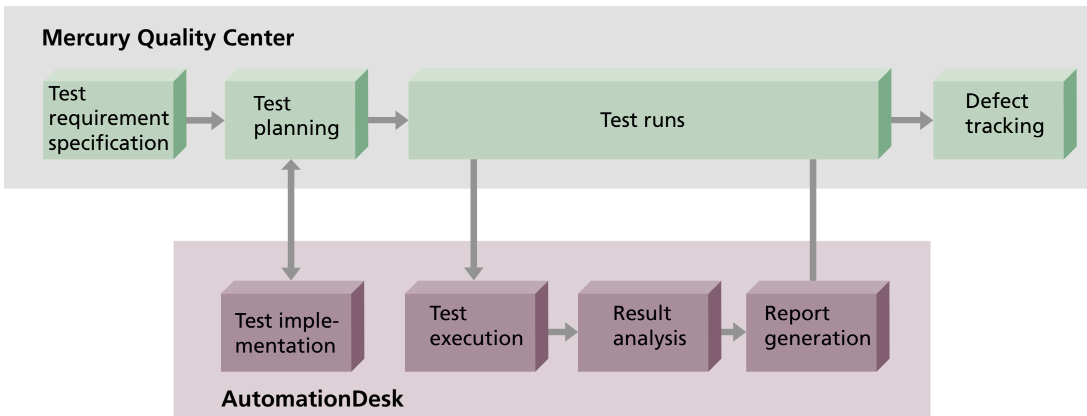


◀ *Flashing at a click: selecting and executing a flash session. An alternative HEX file can be specified, for example, if the latest calibration data has to be flashed.*

A Seamless Test Process

- AutomationDesk connection to Mercury Quality Center™/ TestDirector®
- Access to AutomationDesk via Quality Center Clients
- Central data storage within Quality Center

The open architecture of dSPACE's test automation software AutomationDesk allows it to be used in other development environments. At a customer's request, AutomationDesk can be connected to the Web-based test management tool Mercury Quality Center™ (or Mercury TestDirector®) to provide the benefits of both tools. The result is a seamless tool-based test process from test requirement specification to defect tracking.



▲ *Test process with Quality Center and AutomationDesk.*

Mercury Quality Center and AutomationDesk

When the two programs are linked, tests can be managed and selected in Quality Center and remotely executed in AutomationDesk. Quality Center is used to organize and manage all the phases of the test process, including test requirement specification, test planning, test runs, and defect tracking. Directly test-related tasks like test implementation, test execution, result analysis, and report generation are performed with AutomationDesk, which provides easy access to hardware-in-the-loop platforms, and to measurement and calibration systems. Most test process users do not have to know the handling of AutomationDesk in detail, because important functions of AutomationDesk are available via Quality Center clients.

Benefits of Both Tools

Combining AutomationDesk with Mercury Quality Center provides the features and benefits of both tools:

- Seamless test process from test requirement specification to defect tracking
- Quality Center's process management facilities
- Graphical test development and access to dSPACE Simulator with AutomationDesk
- Central data storage within Mercury Quality Center
- Access to all AutomationDesk tests and results from any Quality Center client

The Interaction

Mercury Quality Center consists of clients (Web server based user front ends) and a server (a database containing tests, defects, workflows, etc.). AutomationDesk and Quality Center are connected via a COM interface. Projects from AutomationDesk can be exported and added to the Quality Center database. AutomationDesk projects can be viewed, parameterized, and executed in the Quality Center client. AutomationDesk's test results and reports are added to the Quality Center database and can be viewed on any Quality Center client.

It is also possible to connect AutomationDesk to Mercury TestDirector, which was recently integrated with Quality Center.

DS2202: Tailor-Made Functions

dSPACE has a new, specially designed board for hardware-in-the-loop (HIL) simulation of transmission and body electronics: the DS2202 HIL I/O Board. Combined with a processor board, it gives users their own tailor-made dSPACE Simulator.

- **New DS2202 HIL I/O Board**
- **Specially designed for transmission and body electronic applications**
- **Software support from Release 5.0**

The cost-effective DS2202 can be installed with a processor board (DS1005 or DS1006) in either dSPACE Simulator or an expansion box for a PC, and also extended by additional boards. Its integrated signal conditioning means an electronic control unit (ECU) can be connected to it directly. Up to now, this was only possible with the DS2211 HIL I/O Board. The two cards are pin-compatible, so the DS2202 can easily be installed in a dSPACE Simulator Mid-Size.

▲ *The new DS2202 HIL I/O Board for specific HIL simulations.*

The DS2202 has the following features:

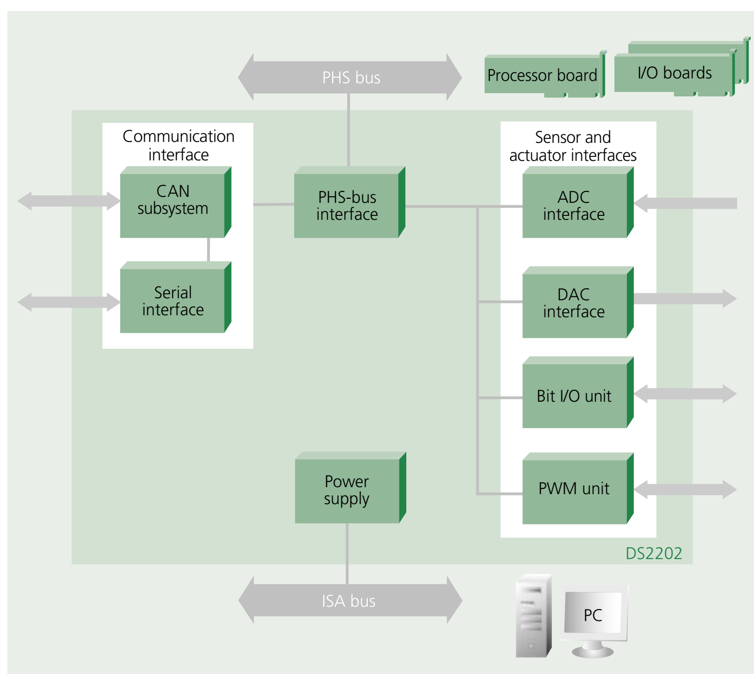
- 20 analog outputs
- 16 analog inputs
- 16 digital outputs
- 38 digital inputs, 24 of which can also be used as PWM inputs
- 9 PWM outputs
- 2 CAN channels
- Serial Interface (RS232/RS422)

The DS2202 can be used in the following areas:

- Transmission applications
- Body electronics (seat adjustment, automatic door lock, vehicle access check, mirror adjustment, etc.)

In the development process, the DS2202 is used from function tests through to release tests. It also serves as an extension to the existing inputs and outputs of dSPACE simulators.

The Real-Time Interface (RTI) software is used to assign the channels on the board to those on the ECU. dSPACE Release 5.0 already provides extensive software support for the DS2202.



▲ *The block diagram of the DS2202.*

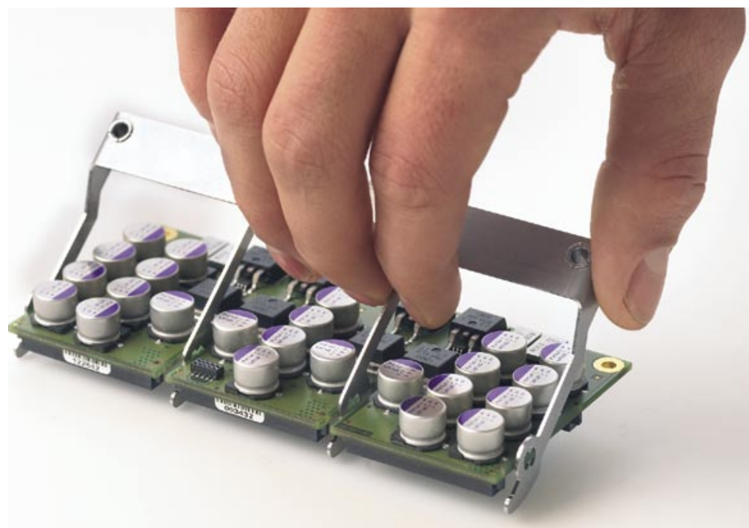
Power Stages for High-Current Actuators

- **Hardware- and software-configurable off-the-shelf modules**
- **High-current modules up to 60 A**
- **Modules for developing motor and engine controls**

Two new powerful power stage modules from dSPACE have output currents of up to 60 A for controlling high-current actuators in rapid control prototyping applications. dSPACE also has two new signal conditioning modules, one for lambda probes and one for knock detection, providing a whole range of extra features for engine management applications. The modules are easy to integrate into the RapidPro system, so tailor-made prototyping solutions for a variety of applications can be implemented quickly and cost-efficiently.

High-Current Modules up to 60 A

Valves in transmission applications, or DC motors for comfort electronics such as tailgates, power windows, and soft tops – whatever it is you want to control, the new high-current modules from dSPACE will give you the necessary current. The DS1667 1-channel full-bridge driver module provides current measurement for closed-loop control as well as 60 A maximum current. The DS1668 2-channel high-current module has two independent half-bridge drivers, each also equipped with current measurement and capable of providing up to 30 A current per channel. Both modules are diagnostics-capable, with mechanisms for detecting faults such as overcurrent and overtemperature. They ideally complement the power stage modules already available for applications in brushless and conventional DC motors, and for controlling high-current valves.



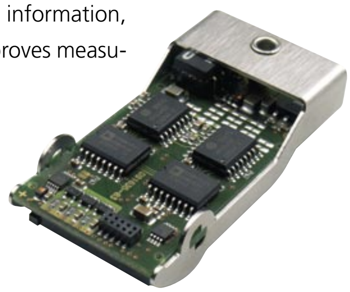
▲ *RapidPro modules can be easily installed into and removed from the units.*

Max. Output Current for the High-Current Modules	
DS1667 	At +25 °C (+77 °F): 30 A continuous per channel, 60 A peak per channel for 1 second
	At +60 °C (+140 °F): 17 A continuous per channel, 60 A peak per channel for 1 second
DS1668 	At +25 °C (+77 °F): 25 A continuous per channel, 30 A peak per channel for 1 second
	At +60 °C (+140 °F): 17 A continuous per channel, 30 A peak per channel for 1 second

New Signal Conditioning Modules

Two signal conditioning modules provide a whole range of extra features for engine management applications.

Knock Detection Module – The new DS1635 2-channel knock detection module lets you capture and evaluate up to four signals on differential or single-ended knock sensors. Digital signal preprocessing is performed by an A/D converter integrated on the chip and a digital signal processor (DSP), considerably easing the load on the RapidPro system's microcontroller. The module is based on the CC196 Knock Detection IC from Bosch and can be configured for various gain factors and three parallel filters of up to order 49 for each knock sensor signal. This allows optimum filtering of interference noise that contains no knock information, and decisively improves measurement results.



Lambda Probe Module – The new DS1634 2-channel wideband lambda probe module was developed especially for engine applications. Up to two Bosch LSU4.2 or LSU4.9 linear lambda probes can be integrated.

The RapidPro System

The RapidPro hardware can be used as an extension to dSPACE prototyping systems (MicroAutoBox, modular DS1005-based system) or as a stand-alone prototyping electronic control unit (ECU). With their compact and robust mechanical design, the units are ideally suited to in-vehicle use, and can also be used on test benches and in the laboratory. The enclosure is designed so that you can use the units separately or connect several of them to build a compact stack. A large selection of hardware- and software-configurable modules provides standard solutions for numerous application cases. Installing the modules is easy, so the RapidPro units can be reused efficiently in different projects. All modules used in conjunction with the RapidPro Units are vehicle-capable and can be installed safely on the carrier boards.

▲ *The flexible hardware platform RapidPro is a tailor-made prototyping solution for a variety of applications.*

BMW Group Relies on TargetLink

- BMW evaluates code generators
- TargetLink chosen
- Process integration activities

The BMW Group evaluated the production code generators currently available on the market. The objective: to find the best code generator for a seamless development process based on MATLAB®/Simulink®/Stateflow®. TargetLink from dSPACE emerged as the most suitable product. We spoke with Dr. Stefan-Alexander Schneider and Robert Meinlschmidt about the evaluation process and the BMW Group's use of TargetLink. They placed particular importance on process integration and process automation.

The BMW Group recently evaluated production code generators. What were the reasons for carrying out this extensive evaluation project?

▲ *Dr. Stefan-Alexander Schneider, process development in the electronic development department.*

S.-A. Schneider: The starting-point was our definition of a new process that could handle future development requirements. We needed a tool chain that was tailored to the new process. So it goes without saying that we examined the available options thoroughly.

What changes were you aiming to make, compared with previous processes?

R. Meinlschmidt: Our objective was a seamless, tool-supported process, from specification, through the analysis and optimization of control algorithms, to automatic code generation. The MATLAB/Simulink/Stateflow development environment was to be integrated as a central element. Another objective of the new process was to introduce new modeling guidelines to give users optimum support in a distributed development environment, along with

"Our objective was a seamless, tool-supported process, from specification, through the analysis and optimization of control algorithms, to automatic code generation."

model creation and code generation procedures that would meet Safety Integrity Level 3. A particular focus was on process automation, to improve integration and reduce the error rate.

How did you set about performing the evaluation?

S.-A. Schneider: To start with, we agreed on a comprehensive scoring scheme. Divided into five areas,

"To start with, we agreed on a comprehensive scoring scheme."

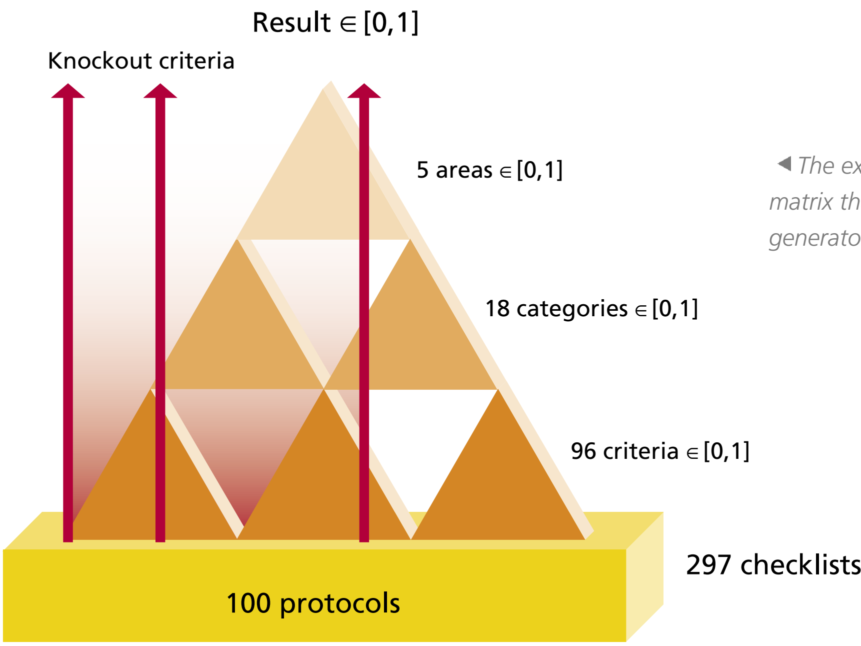
with 18 categories and 96 criteria, 21 of which were knockout criteria that were visible at the decision level.

What were the criteria?

S.-A. Schneider: In addition to general tool properties, we also evaluated the extent of support given to Simulink/Stateflow functions, suitability for use in safety-relevant applications, integration into the development process, and of course the properties of the generated code itself.

What was the next step after completing the evaluation?

R. Meinlschmidt: We realized that we had to harmonize processes and tools for direct use in everyday project work. We did this by analyzing the existing processes and production projects that were already running with TargetLink. The insights gained from this were incorporated in a method manual for using MATLAB/Simlink/Stateflow and TargetLink. The resulting workflows were then automated in accordance with the process. TargetLink's application programming interface,



The extensive evaluation matrix that the production code generators had to run through.

the on-site service provided, and dSPACE's experience in this field all played a major role in this.

How important to you are future adaptations to your processes and tool chains?
S.-A. Schneider: Adapting the tools to our processes is very important to us, to ensure we derive maximum benefit from the tools. We also want to keep in close touch with the tool suppliers, so that we are informed in good time of their development strategies, and can make our own requirements clear to them. We're on the right road with TargetLink and cooperation with your company.

In concrete terms, what do you expect of TargetLink in upcoming production projects?
S.-A. Schneider: We want a seamless, optimized development process that will cut development times, simplify iterations, and guarantee reliable implementation of the modeled functions on the target hardware. We chose TargetLink to do this. So that we can be flexible and integrate existing code into the autogenerated code if need be, the good readability of TargetLink code is very important to us.

> *"We want a seamless, optimized development process that will cut development times, simplify iterations, and guarantee reliable implementation of the modeled functions on the target hardware. We chose TargetLink to do this."*

R. Meinlschmidt: Alongside expectations regarding the actual tool, we also want fast, competent support from the tool supplier.

To what extent will the BMW Group use automatic code generation?
S.-A. Schneider: Our goal is to use automatic code generation wherever we do model-based development. It's the way to go: Model-based development and MATLAB/Simulink/Stateflow will grow in importance, and therefore so will automatic production code generation.

Thank you for talking to us.

Robert Meinlschmidt, process development in the electronic development department.

In the Land of the Rising Sun

dSPACE has more than 15 years of history in Japan. President Dr. Herbert Hanselmann looks back at how it all began, in a country that has since become one of dSPACE's largest export markets. As the changes planned for 2006 show, we aim to continue the success story into the future.

It must have been 1989 when dSPACE first did business with a Japanese customer. An engineer from Nippondenso phoned excitedly to say we had precisely the DSP tool he so urgently needed. Then he sent the money, then the purchase order (not the other way round). Encouraged by this experience, dSPACE contacted two distributors in Japan. However, after thorough consideration, both of them declined to distribute dSPACE products in Japan, one for reasons of competition, the other "because there is no market for DSP control tools in Japan".

▲ View over Yokohama.

Nobuo Murakami saw things differently. He had just founded the LinX company, and after due investigation, he decided to take the risk. There followed fifteen successful years; indeed, 2005 was a particularly strong year. Over this period, the Japanese market has become one of dSPACE's largest export markets. We stay in close touch with many customers and regularly visit one another.

▲ The office towers where dSPACE Japan K.K. has its home.

The LinX era will draw to a close in March 2006. dSPACE Japan K.K., a subsidiary of dSPACE GmbH, was already founded and moved into its premises in Yokohama. The Japanese section of the dSPACE Web site is up and running.

The plan is for approx. 30 employees, to cover not only sales, consultation, and support, but also on-site engineering projects. These will mainly be hardware-in-the-loop projects, a field which we feel is experiencing intense change and high demand in Japan.

Several Japanese employees and engineers from Paderborn are already dealing with presales tasks in Yokohama, and taking care of post-sales support. Six engineers from Paderborn are preparing for a lengthy period as expatriates in Japan. They can already manage to say "Konnichi-wa" in greeting, and are looking forward to this interesting new challenge.

LinX will continue to perform administrative tasks until the Japanese business year ends at the end of March 2006, after which all duties will pass to dSPACE Japan K.K. We'll bring you more details when the time comes.

Dr. Herbert Hanselmann
President

What Our Customers Said

We take our customers' opinions very seriously. So last August, we held a detailed survey of their views on our products, sales activities, support, and engineering services. We are happy to report that as in our previous survey in 2003, we were given positive scores on all these points. Everyone who returned the questionnaire took part in a draw for three iPod nanos from Apple.

- **Customer satisfaction survey**
- **Good result for dSPACE**
- **Draw for 3 Apple iPod nanos**

▲ *The draw for the prize-winners was performed by dSPACE employee Viola Gabler under the supervision of our lawyer, Timm de Beer.*

We e-mailed and telephoned our customers in Germany asking them for their assessment of dSPACE's performance. The response was excellent, and the result very positive. In almost all the individual areas, our scores were even higher than in 2003, with more than 90% of the responses giving dSPACE's overall performance the two top marks. Our relationship with our customers reaped particularly high scores in all its forms – support, sales, and engineering services – thus validating our corporate philosophy. This success motivates us to go on listening to what our customers have to say, to enhance our performance in tune with their needs.

We held a draw among all the respondents for three Apple iPod nanos. The winners are:

- Heiko Braun, Porsche AG
- Dr. Johann Fuchs, AUDI AG
- Jochen Zapletal, ZF Lenksysteme

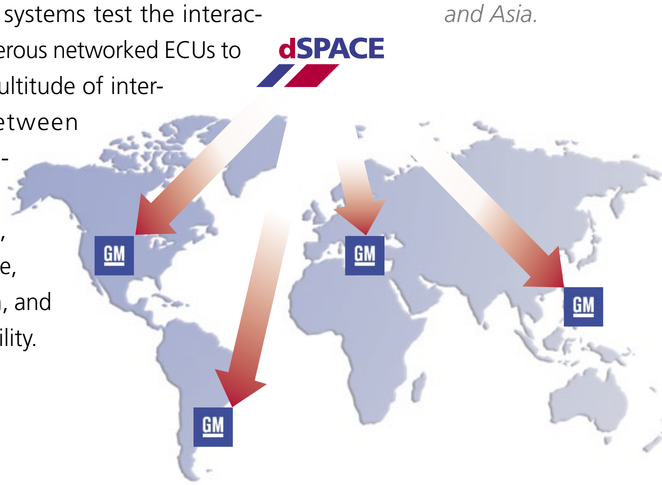
Our congratulations to them.

dSPACE to Provide General Motors with Hardware-in-the-Loop

General Motors has selected dSPACE as their preferred worldwide supplier for hardware-in-the-loop (HIL) technology systems.

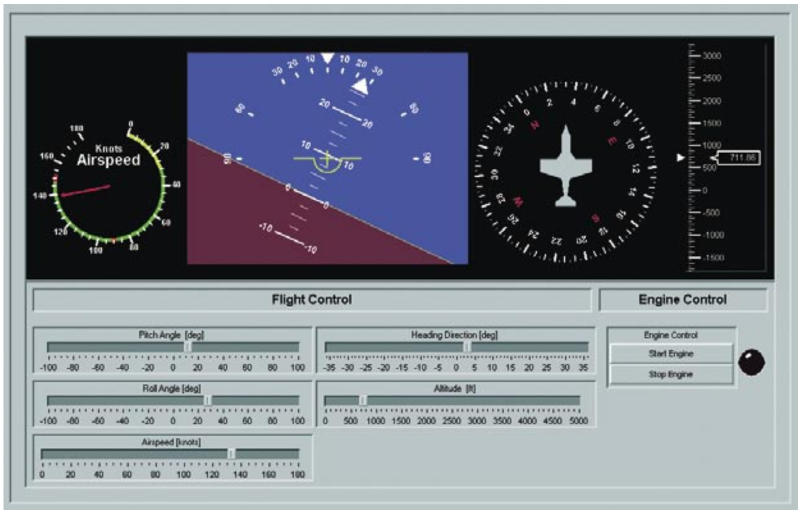
dSPACE HIL technology emerged on top after a tough selection process. The products had never before been subjected to as thorough an evaluation process in advance of a purchase as was carried out by GM. dSPACE HIL simulators have been used successfully by GM groups in Europe. Now GM in North America and other locations can be added to dSPACE's HIL customer set.

General Motors employs numerous HIL systems in its worldwide technology centers to test electronic control units (ECUs) and the functions they control in subsystems, systems, and ultimately entire vehicle networks. The component test systems may test only one function, such as mirror directional controls, within a single ECU. On the other hand, large-scale integration systems test the interaction of numerous networked ECUs to control a multitude of interactions between vehicle systems such as lighting, safety, engine, transmission, and vehicle stability.



▼ *dSPACE will provide HIL systems to GM technical centers in North America, Europe, South America and Asia.*

Airborne with ControlDesk



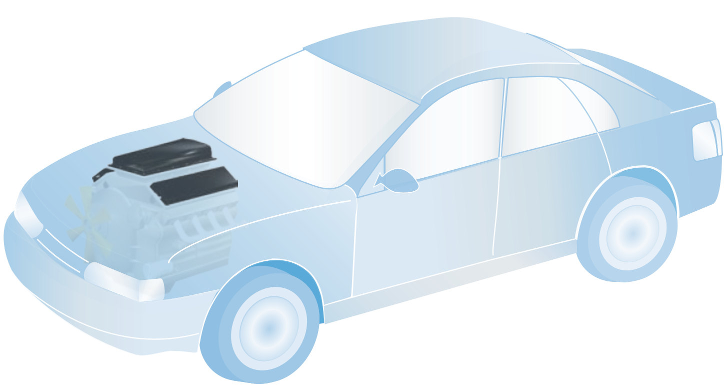
To test aircraft systems, dSPACE has added special aviation instruments to ControlDesk, its experiment software. The graphical experiment environment now includes an artificial horizon, an altimeter, and a heading indicator, enabling the software to meet an even wider range of user requirements.

Compatibility Update for TargetLink

Hot on the heels of MATLAB R14 Service Pack 3, dSPACE issued a compatibility update for users of production code generator TargetLink 2.1. Called TargetLink 2.1.5, the update guarantees smooth interaction between TargetLink and the latest MATLAB®/Simulink®/Stateflow® version.

Turbo Simulation

dSPACE has added a turbocharger simulation model to its Automotive Simulation Models (ASMs). The turbocharger model simulates a physical exhaust turbocharger with variable turbine geometry (VTG) and computes the shaft speed and other variables. For further information, please use our response card or visit *www.dspace.com*



New in dSPACE NEWS: Glossaries

The articles on our customers' applications now include glossaries with brief explanations of specialist terms. This extra feature aims to make the articles accessible to a wider audience. Each glossary is in a box at the end of the article – here's an example:

Glossary

IGBT – semiconductor component used in power electronics

FPGA – freely programmable logic circuits

PWM – modulation of a signal's mark space ratio at a constant frequency

On the Move

Our subsidiary in France, dSPACE Sarl, has moved to a new location. Their new offices are just a stone's throw away from the old address.

The new address:
dSPACE Sarl
Parc Burospace, Bâtiment 20
Route de la plaine de Gisy
91573 Bièvres Cedex

Events

EUROPE

Euroforum – Elektroniksysteme im Automobil
February 8-9, Munich, Germany
Dorint Sofitel Bayerpost
http://www.euroforum.com

Embedded World
February 14-16, Nuremberg, Germany
NürnbergMesse, Hall 10, Booth 125
http://www.embedded-world-2006.de

AUTOREG 2006
March 7-8, Wiesloch, Germany
Palatin Congress Hotel, Wiesloch
http://www.vdi-wissensforum.de/

Aerospace Testing Expo
April 4-6, Hamburg, Germany
Hamburg Messe, Hall A1, Booth 656
http://www.aerospacetesting-expo.com

Euroforum – Software im Automobil
May 3-4, Stuttgart, Germany
Le Méridien, Stuttgart
http://www.euroforum.com

Automotive Testing Expo
May 9-11, Stuttgart, Germany
Messe Stuttgart
http://www.testing-expo.com

USA

SAE Congress
April 3-6, Detroit, MI
Booth 1701
http://www.sae.org/congress/2006

dSPACE US User Conference 2006
2.-4. Mai, Plymouth, MI, USA
St. John's Conference Center
http://www.dspace.com

Japan

Japan SAE 2006
24.-26. Mai, Yokohama, Japan
Pacifico Yokohama complex
http://www.jsae.or.jp

dSPACE Japan K.K. User Conference 2006
23. Mai, Shinagawa, Tokyo, Japan
Tokyo Conference Center Shinagawa

For further events visit *www.dspace.com*

Request Infos

Please check the corresponding field on your response card and return it

- By mail
- By fax to +49 52 51 – 6 65 29

- Request information via our Website *www.dspace.com/goto?dspace-news-info*
- For more details, visit *www.dspace.com*
- Send us an e-mail at *dspace-news@dspace.de*

Your opinion is important. Please send your criticism, praise, or comments to *dspace-news@dspace.de* – thank you!

Job Opportunities

Are you an engineer who is just graduating? Or are you looking for new professional challenges? Then come and join our team in Paderborn, Munich or Stuttgart, Germany; Paris, France; Cambridgeshire, United Kingdom; Novi, MI, USA or Yokohama, Japan!
Due to our continuous growth, dSPACE is looking for engineers in

- Software development
- Hardware development
- Applications
- Technical sales
- Product management

Training

Please check the corresponding field on your response card.

- AutomationDesk
- Automotive Simulation Models
- CalDesk
- ControlDesk
- dSPACE Real-Time Systems
- Hardware-in-the-Loop-Simulation
- MotionDesk
- Rapid Control Prototyping with CalDesk
- RapidPro
- TargetLink

Australia
CEANET Pty Ltd.
Level 1, 30 Little Cribb Street
Milton
Queensland 4064
Tel.: +61 7 3238 5300
Fax: +61 7 3211 4791
info@ceanet.com.au
www.ceanet.com.au

China and Hong Kong
Hirain Technologies
Beijing Chuangye Plaza, No.11
8/F., Unit B
An Xiang Bei Li Jia
Chaoyang District
Beijing 100101
Tel.: +86 10 648 406 06
Fax: +86 10 648 482 56
ycji@hirain.com
www.hirain.com

Czech and Slovak Republic
HUMUSOFT s.r.o.
Pobrenzi 20
186 00 Praha 8
Tel.: +420 2 84 01 17 30
Fax: +420 2 84 01 17 40
info@humusoft.cz
www.humusoft.cz

India
Cranes Software Intern. Ltd.
#29, 7th Cross, 14th Main
Vasanthnagar
Bangalore 560 052, India
Tel.: +91 80 22381740
Fax: +91 80 22384317
info@cranessoftware.com
www.cranessoftware.com

Israel
Omikron Delta (1927) Ltd.
10 Carlebach St.
Tel-Aviv 67132
Tel.: +972 3 561 5151
Fax: +972 3 561 2962
info@omikron.co.il
www.omikron.co.il

Korea
MDS Technology Co., Ltd.
15F Kolon Digital Tower Vilant 222-7
Guro-3-dong, Guro-gu
Seoul 152-848, South Korea
Tel.: +82 2 2106 6000
Fax: +82 2 2106 6004
dspace@mdstec.com
www.mdstec.com

Netherlands
TSS Consultancy
Rietkraag 37
3121 TC Schiedam
Tel.: +31 10 2 47 00 31
Fax: +31 10 2 47 00 32
info@tsscon.nl
www.tsscon.nl

Poland
Technika Obliczeniowa
ul. Obozna 11
30-011 Kraków
Tel.: +48 12 423 39 66
Fax: +48 12 632 17 80
info@tobl.krakow.pl
www.tobl.krakow.pl

Sweden
FENGCO Real Time Control AB
Hallonbergsplan 10
Box 7068
174 07 Sundbyberg
Tel.: +46 8 6 28 03 15
Fax: +46 8 96 73 95
sales@fengco.se
www.fengco.se

Taiwan
Scientific Formosa Incorporation
11th Fl. 354 Fu-Hsing N. Road
Taipei, Taiwan, R.O.C.
Tel.: +886 2 2505 05 25
Fax: +886 2 2503 16 80
info@sciformosa.com.tw
www.sciformosa.com.tw

Headquarters in Germany
dSPACE GmbH
Technologiepark 25
33100 Paderborn
Tel.: +49 5251 1638-0
Fax: +49 5251 66529
info@dspace.de

USA and Canada
dSPACE Inc.
28700 Cabot Drive
Suite 1100
Novi · MI 48377
Tel.: +1 248 567 1300
Fax: +1 248 567 0130
info@dspaceinc.com

Japan
dSPACE Japan K.K.
West Tower 9F
Yokohama Business Park
134 Godo-cho · Hodogaya-ku
Yokohama-shi
Kanagawa-ken 240-0005
Tel.: +81 45 338 3361
Fax: +81 45 338 3362
info@dspace.jp

France
dSPACE Sarl
Parc Burospace · Bâtiment 20
Route de la Plaine de Gisy
91573 Bièvres Cedex
Tel.: +33 1 6935 5060
Fax: +33 1 6935 5061
info@dspace.fr

United Kingdom
dSPACE Ltd.
2nd Floor Westminster House
Spitfire Close
Ermine Business Park
Huntingdon
Cambridgeshire PE29 6XY
Tel.: +44 1480 410700
Fax: +44 1480 410701
info@dspace.ltd.uk

dSPACE

www.dspace.com