

Networked Tests at ZF

- ZF Friedrichshafen boosts efficiency by seamless tool landscape
- AutomationDesk, ControlDesk and MotionDesk for ECU tests
- Test automation is a major element in HIL testing

With increased networking of vehicle electronics, optimized validation methods and processes are vital. One important quality assurance activity is to run defined, standardized tests on electronic control units (ECUs) at various stages of development. Hardware-in-the-loop (HIL) tests are a major part of this process. They range from tests on single ECUs, to the validation of entire system areas, and right through to representations of whole vehicles. The seamless use of dSPACE hardware and software throughout the process provides a highly efficient test environment.

ZF Friedrichshafen AG is a system supplier that develops and produces electronically controlled drivetrain, steering, and vehicle systems. HIL testing is an important element in our development process, enabling us to detect and remedy errors in the laboratory at an early stage, and also to boost testing efficiency by means of reusable test cases.

dSPACE Technology for Rapid Prototyping and HIL Test Stations

ZF Friedrichshafen AG offers a wide range of drivetrain and chassis systems. The ways in which we use dSPACE systems are correspondingly varied, with regard to both rapid prototyping and hardware-in-the-loop technology. For HIL tests especially, we frequently employ dSPACE test stations equipped with the appropriate tool chains, for example, ControlDesk, AutomationDesk, and MotionDesk. We use the dSPACE

technology for tests on single ECUs, called component testing, for network testing of ECUs, and for virtual test drives using vehicle models. ZF Friedrichshafen has constructed a powerful network test station for testing the entire aggregate of drivetrain and chassis controls. The test station includes such items as all-wheel drive with control systems for the automatic, distributor, and axle transmission; for slip controller systems; and for the active chassis.

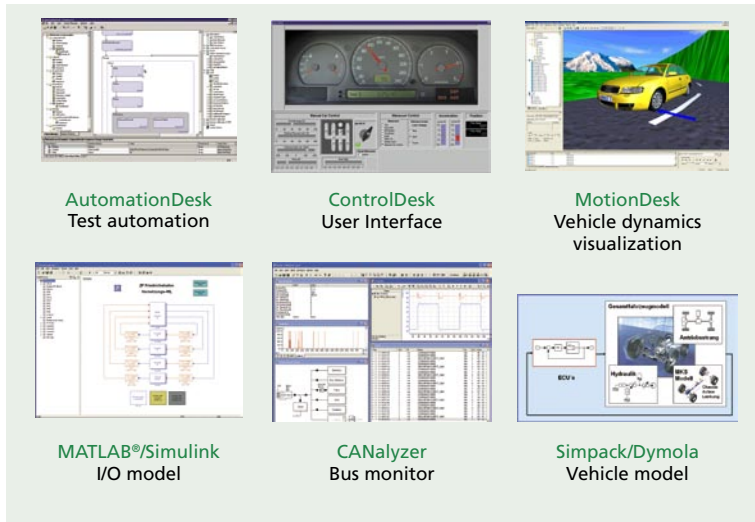
Network Testing

Bringing individual components together in the vehicle involves an enormous amount of work. Frequently, the first time that components interact is after installation in the laboratory vehicle. Much less time is needed to put the vehicle into operation if component interaction is tested beforehand. We integrate the target vehicle's most important ECUs and investigate how they behave in a network. The focus is on their reciprocal effects and ECU-independent functionalities, for example:

- The ECU network's reaction to faults in the vehicle electrical system
- The robustness of the system network when individual components malfunction
- Effects due to different features in different vehicle variants
- Evaluating the controllers with regard to vehicle dynamics

▼ HIL simulators for testing networked ECUs.





test library ensures optimum test reusability. It is divided into two parts. The first is the test module library, which contains elementary test modules that can be reused in several test cases. The second part is the test case library; this holds the complex, ECU- and vehicle-specific test cases, which are basically built up using the test modules. Our customers benefit from this test library, which we naturally make use of in joint projects.

▲ Part of the tool landscape in the network test station at ZF Friedrichshafen.

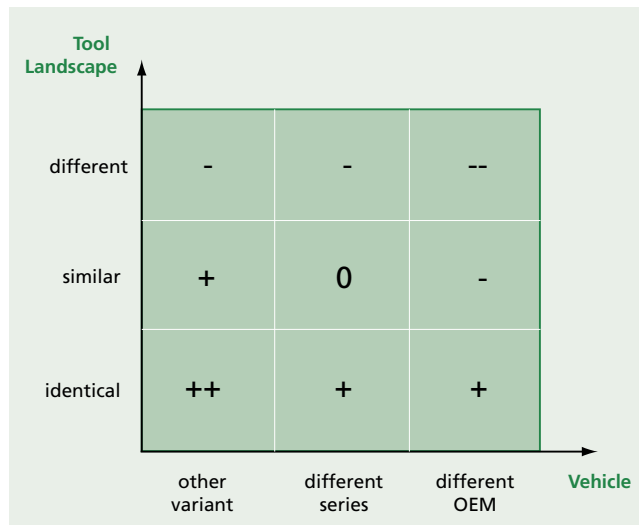
The mechanical systems that the ECUs are installed in are simulated in real time. A dSPACE multiprocessor system with associated I/O calculates the vehicle model and the sensor signal emulation for the ECUs. We use MotionDesk, the 3-D animation software, to visualize the virtual test drives realistically in 3-D scenes.

Test Automation

Complex systems require a large number of tests, but the actual test sequences are continually repeated. Test automation is extremely helpful here. To keep the costs as low as possible, we create test case libraries. These hold collections of test specifications and associated test cases, which are used in various projects. Thus, we do not have to program diagnostic tests from scratch for every product, but can use the ones we have for several ECUs. dSPACE’s test and experiment software, AutomationDesk, enables us to run test sequences in a reproducible manner and with reproducible quality, avoiding the deviations that arise with manual test execution. Moreover, automatic tests can run overnight and on weekends, so we have a minimum of routine tasks to do ourselves. AutomationDesk generates test reports, and all we have to do is look at the results and interpret them.

Reusability Potential of Test Cases

ZF Friedrichshafen has more than 20 years of experience in using hardware-in-the-loop technology. We have accumulated a wide range of knowledge on test methods and test cases during this period. One of our major know-how resources is a comprehensive test library implemented by means of AutomationDesk. The



▲ The cost/benefit ratio for reusability potential according to tool landscape and target vehicle.

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Glossary

- Laboratory vehicle –**
Vehicle test bench for testing interaction between ECUs.
- Test case –**
Defined test sequence with specifications for specific functions.