VDC development

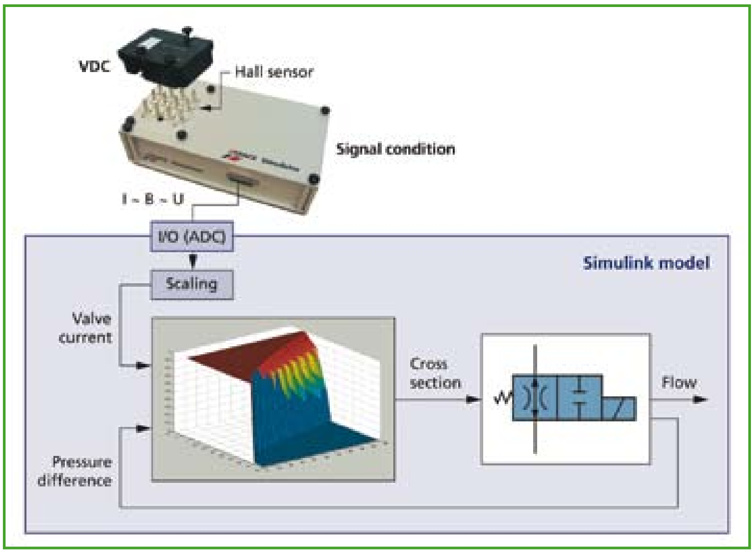
More elaborate and efficient vehicle dynamics controllers (VDCs) like anti-lock brakes (ABS), electronic stability programs (ESP), and traction control systems (TCS) are major features of modern passenger cars. Hardware-in-the-loop (HIL) test benches are indispensable for their timely development and validation. Today, HIL tests can be regarded as a standard methodology because of the safety-critical nature of the multi-sensor and multi-actuator systems used in vehicle dynamics control.

dSPACE has a long history of developing HIL simulators for VDC testing and recently introduced its own simulation models, which support function designers from the design phase to the validation phase for VDCs. These models, called Automotive Simulation Models (ASM), are available for engine and vehicle dynamics simulation. They support real-time simulation of everything from components such as brake hydraulics or turbochargers to an entire virtual vehicle.

A complete vehicle model is needed to perform closed-loop testing of VDC controllers. The synthetic simulation of sensor signals is particularly important, for example, for steering wheel position, lateral/longitudinal acceleration, yaw rate, wheel speeds, and hydraulic pressure – all of which are required by the VDC.

Controlling brake forces at each wheel is the main task of a VDC system and is normally performed by hydraulic valves actuated by solenoids. Since these devices are enclosed within the housing of the ECU itself, a special device, called a valve signal detection unit, is used to measure the valve actuation.

For instance, the physical actuator valves of a vehicle's brake hydraulics system are replaced by metal pins equipped with Hall sensors to measure the magnetic field induced by the coil current of the VDC. The measured signals are delivered to the ASM Brake Hydraulics Model, which simulates the hydraulic unit including valves, reservoirs and pumps.

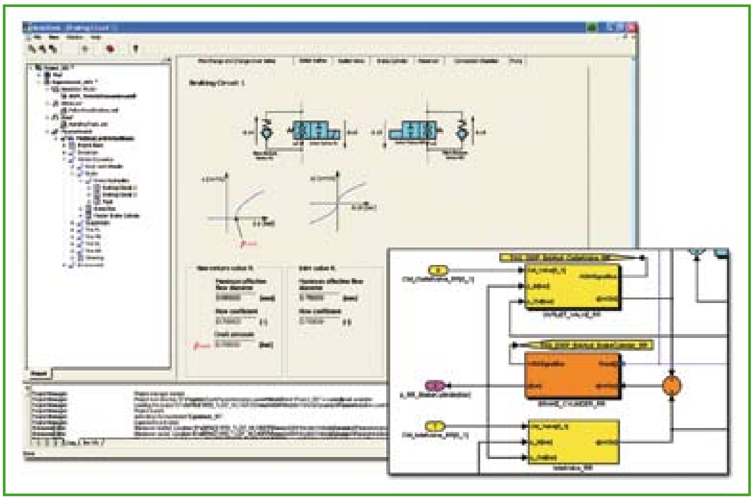


ABOVE: **SCHEMATIC SHOWS HOW THE ACTUATOR SIGNALS OF A VDC ARE MEASURED VIA THE I/O OF THE SIMULATOR. THE SIGNALS ARE THEN COMPUTED USING THE ASM BRAKE HYDRAULICS MODEL**

Model quality and performance are central to simulation precision. Signals have to be computed consistently and in the correct physical relation to the corresponding actuator signals. For precise representation of physical valve characteristics, hydraulic valves are modeled as orifices with continuously controllable cross-sections.

The brake hydraulic model must be regarded as a stiff system. To overcome stability and performance problems during interaction with the vehicle model, ASM Brake Hydraulics performs local oversampling. This guarantees numerically stable integration with a resulting step size of 1ms for the overall system. With a turnaround time of nearly 100µs on a current real-time processor board, a lot of headroom is available.

The ASM Brake Hydraulics Model integrates seamlessly with the ASM Vehicle Dynamics Model, so simulated test drives can be performed in virtual environments. Standard maneuvers like split-µ braking are already included. Individual maneuvers can be defined graphically and performed in real time.



GRAPHICAL PARAMETERIZATION OF THE BRAKE HYDRAULICS MODEL WITH MODELDESK FROM DSPACE

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