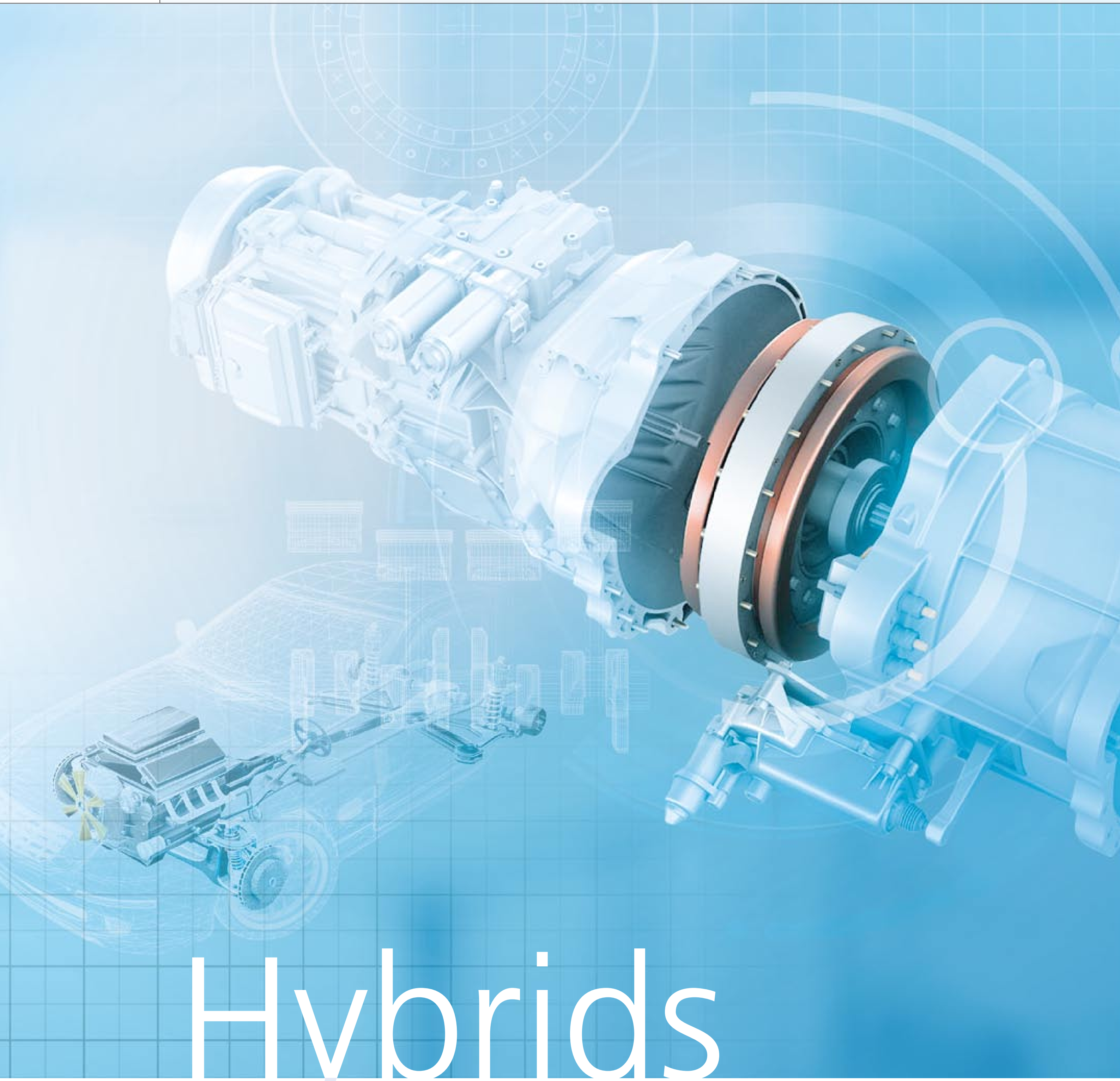


Hybrids under Control

Developing and Testing ECUs for Hybrid Drives and Electric Motors

A current goal for vehicle developers is to reduce CO_2 emissions yet maintain a high standard of driveability. For many car makers, hybrid drives are one solution. What challenges do they face? What products give them support? dSPACE provides the answers.

When a vehicle's combustion engine is supplemented by an electric motor, either the existing electronic control units (ECUs) need additional functions, or completely new ECUs have to be added. Electric motor ECUs are characterized by extremely dynamic behavior, which means short sampling times and control loops in signal capture. Function development has to take this into account, and so do the tests. dSPACE provides comprehensive hardware and software for this.

Function Development
Efficient function development means being able to try out and test new algorithms flexibly, without having to think about how to implement them on the target platform. dSPACE prototyping systems can represent either parts of the ECU under development, or even the whole ECU. For example, they might represent the top-level central hybrid controller, or they might directly control the auxiliary units required for hybrid operation, such as gasoline and water pumps.

Prototyping with dSPACE
When a dSPACE prototyping system is used for function development, users are not bound by the restrictions that will be imposed later by the ECU itself. Instead, they have high computation performance and enormous memory capacity. They can transfer new functions to the prototyping system from a MATLAB®/ Simulink® model with push-button

ease in dSPACE Real-Time Interface (RTI). This makes it possible to perform fast iterations.
Moreover, dSPACE prototyping systems can also be used in the actual vehicle, so that functions can be verified not only in the laboratory, but also in actual driving operations.

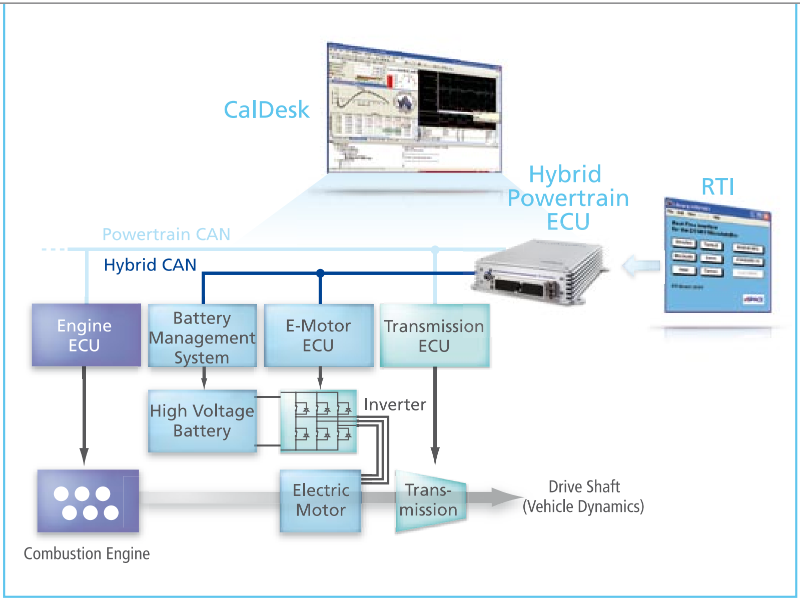


Figure 1: The dSPACE MicroAutoBox is used as a central hybrid ECU during development.

Typical Use Scenarios

1) Developing a hybrid controller:

The dSPACE MicroAutoBox is ideal for developing a top-level, central hybrid controller (figure 1). It has the necessary bus interfaces – CAN, LIN, FlexRay, etc. – and also additional I/O. It is just as easy to run in ECU networks as an actual ECU, so it integrates seamlessly. And with its small, compact design, it can also be installed in the vehicle.

2) Electrifying various auxiliary units:

Electrifying the various auxiliary units requires a modular, scalable system for integrating new functions or ECU software into existing ECUs. This is where the dSPACE AutoBox comes in (figure 2). Used together with the signal conditioning and power stage modules of the dSPACE RapidPro system, it provides a completely configurable solution. Control signals for block/sine commutation, I/O interfaces for Hall sensors and encoders, are available to users. Sensorless processes are supported by precise measurements of powertrain voltages and motor currents. Measurements and parameters can be changed during run time with dSPACE CalDesk. This measurement and calibration software is optimized for in-vehicle use on a notebook.

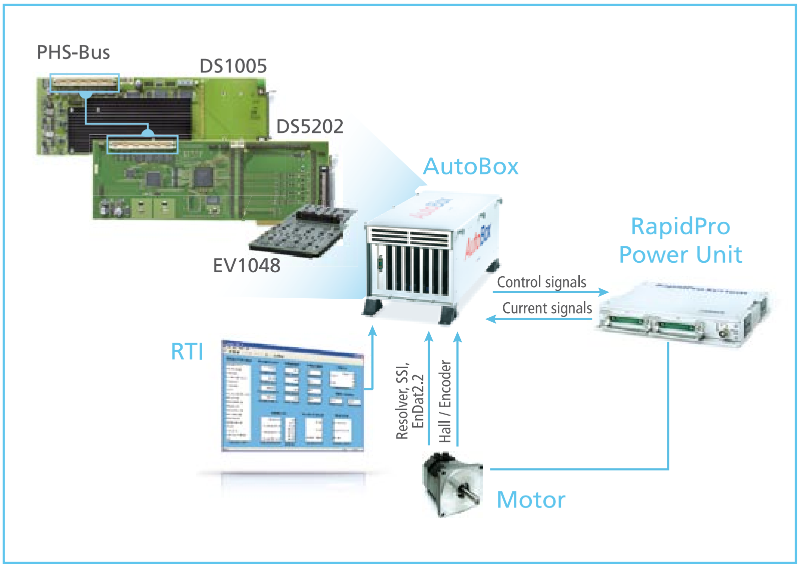


Figure 2: The dSPACE AutoBox can be flexibly adapted to the requirements of different electric motors.

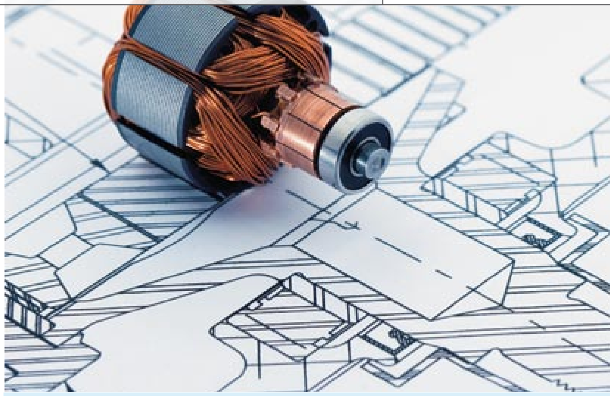
Testing ECUs for Hybrid Drives

To test the new ECU functions, the ECU is connected to a hardware-in-the-loop (HIL) simulator that simulates the rest of the hybrid drivetrain. The modular design of dSPACE simulator hardware allows users to set up different types of hybrids such as:

- Serial and parallel hybrid drives
- Micro hybrid drive with starter and generator
- Mild and full hybrid drives

HIL Tests with dSPACE

In a typical simulator setup for hybrid drives, the transmission, engine, and battery simulations are implemented in different simulators. These contain two parallel CAN networks – a drive CAN and a hybrid CAN. The drive CAN connects the standard ECUs, such as those for the engine or the transmission. The hybrid-specific ECUs communicate via the hybrid CAN (figure 3). ECUs that are not yet available are represented in these networks by restbus simulation so that an entire vehicle can be simulated.
To achieve the short sample times required for electric motors, the



dSPACE's mature products support the development of ECUs for hybrid drives from the first design to the final test.

signals have to be preprocessed. dSPACE offers its PWM (pulse width modulation) and PSS (position sensor simulation) solutions for this. These interact closely with the processor to calculate the electric motor model. If the ECU under test requires precise current behavior, the dSPACE Electronic Load Module is used. This feeds the real current to the ECU. To control the module, parts of the electric motor model are moved out to the dSPACE FGPA Board to be calculated.

Simulation Model

Real-time simulation models are indispensable for HIL tests. dSPACE's Automotive Simulation Models include an Electric Component Library especially for electric motors. The model components from the library can be integrated into existing models. Simulating battery behavior and integrating electric motors into a hybrid vehicle are just two of the library's typical applications. ■

Further Developments

At dSPACE, we are constantly expanding our product range, and strongly believe in modularity. An upcoming example: RapidPro will soon have new modules for controlling brushless motors.
Our goal is to continue supporting developers in the future, from the initial function design to the final integration test. To ensure we are the ideal development partner, dSPACE is dedicated to providing innovative products.

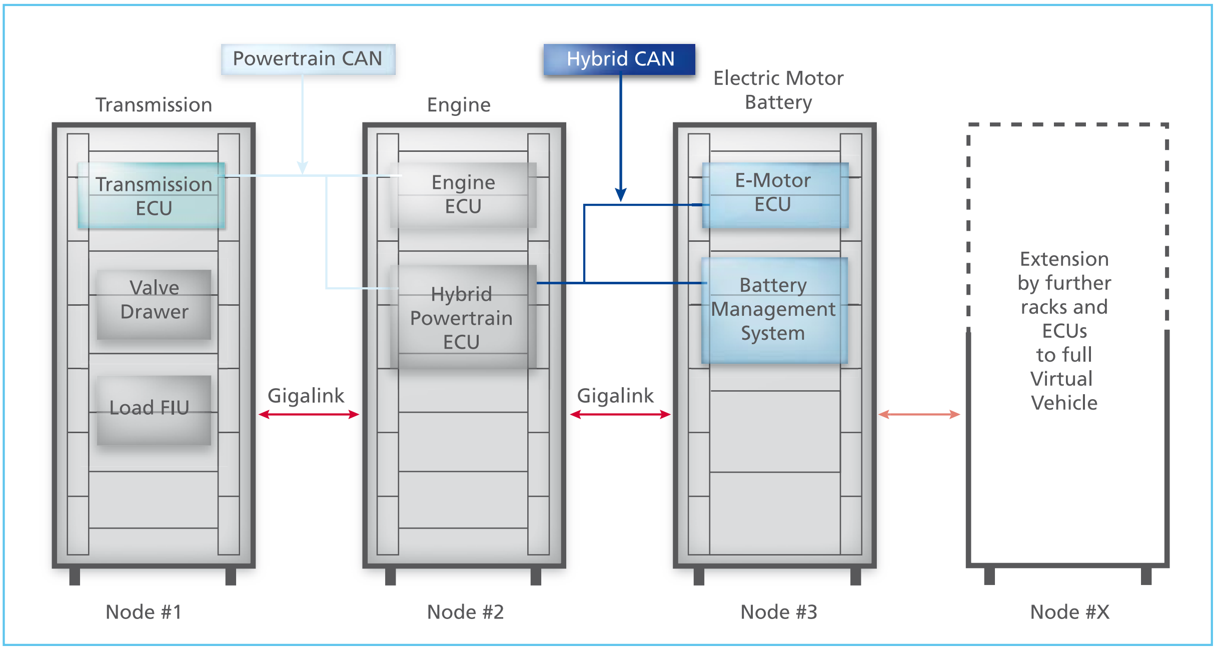


Figure 3: Example setup of an HIL test system for a hybrid drive.