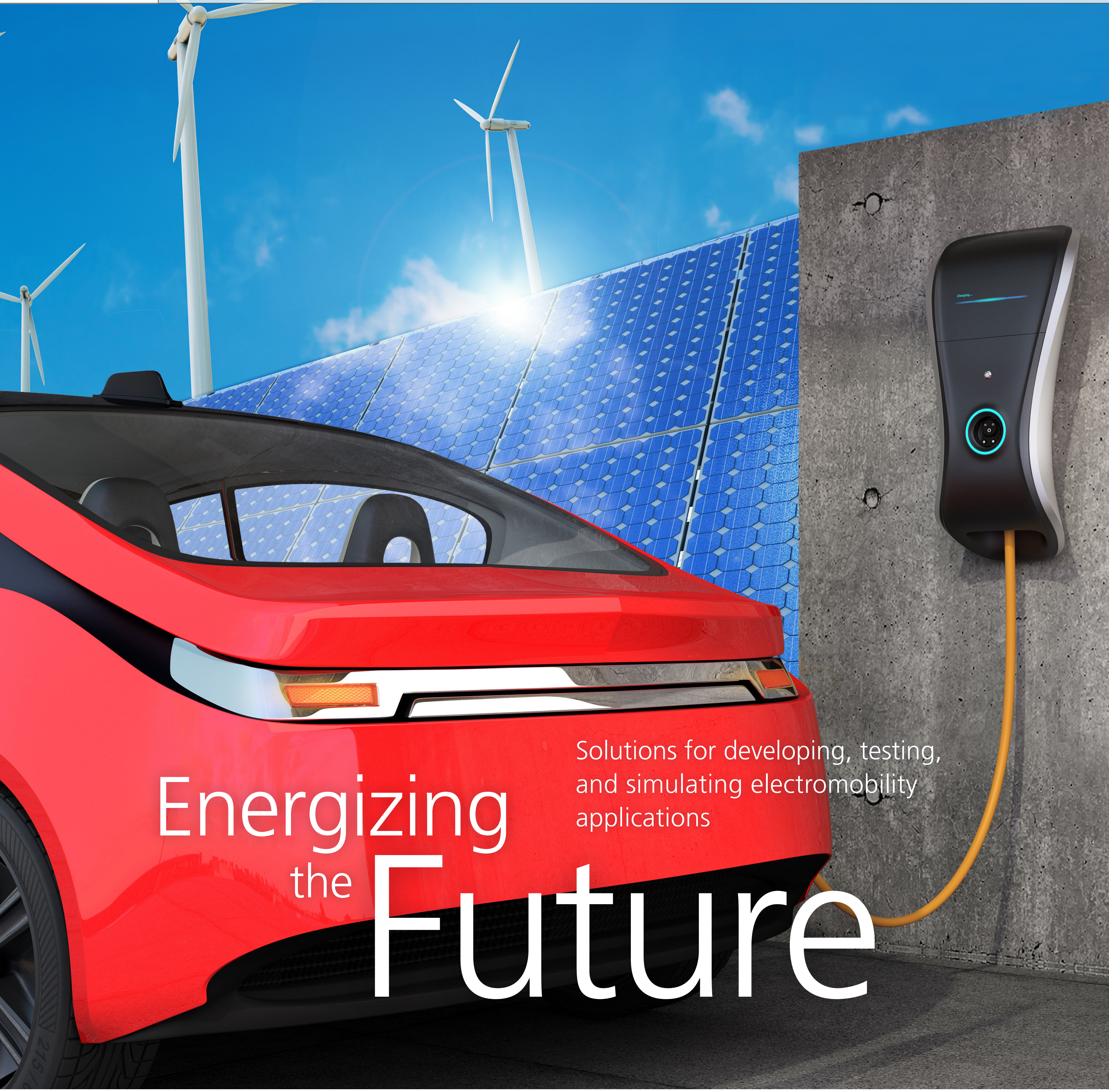


Energizing the Future

Solutions for developing, testing, and simulating electromobility applications

Electromobility has long become a complex industrial branch that encompasses much more than just the electric vehicle. Based on dSPACE's longstanding experience, the company provides a well-engineered product portfolio and innovative solutions that cover the entire range of electromobility applications – from energy generation and distribution, to charging stations, to energy storage systems.

There is no ignoring electromobility in this day and age. Each OEM and supplier designs their own electric vehicles and required components. Stricter regulations on emissions and an increasing demand from countries such as China open up profitable market opportunities. Electromobility has three core topics:

- Electrifying the vehicle, including driveline, energy storage systems, and auxiliary units, such as the steering system
- Establishing a charging infrastructure
- Creating and distributing the electrical energy

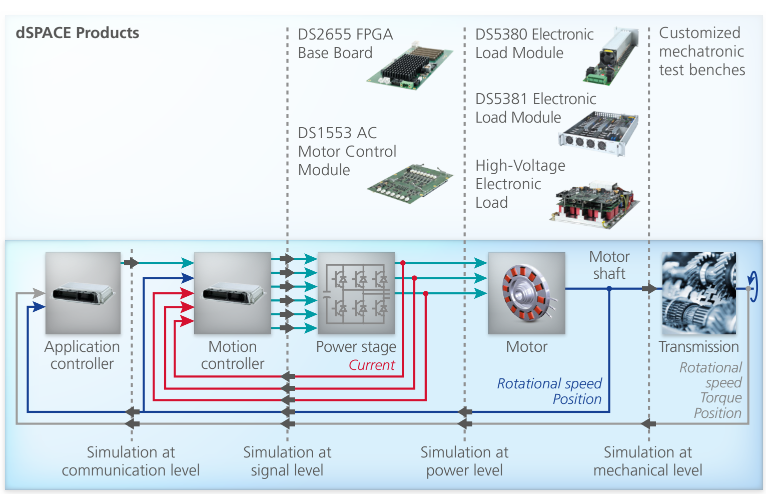
dSPACE has been active in the area of electric drives for years. For example, in 1997 we worked with Adtranz to develop an electric locomotive drive, and in 1998 with ABB to develop a hardware-in-the-loop simulator for the simulation of power electronics. We have continuously broadened our product range for electromobility on the basis of these and many other projects. It now covers all required development steps – from function development to production code generation to testing and simulation.

Electric Vehicles

Electric Motor

Unlike combustion engines, electric motors are much more dynamic and generate high torque even at low rotational speeds. Their power ranges from a few Watts to several hundred kW. To meet the high dynamic requirements, the dSPACE portfolio includes powerful FPGA platforms, which can also be integrated in **MicroAutoBox II** or the **SCALEXIO systems**. To do this, the **DS2655 FPGA Base Board** was added for the SCALEXIO systems, for example. Users can either use existing FPGA models, such as the **XSG Electric Components Library,** or program the FPGA themselves by using the **RTI FPGA Programming Blockset** or the **XSG Utils Library**. To perform validation under realistic conditions, dSPACE provides electronic loads to emulate electric motors that support tests at power levels of 100 W to 500 kW (figure 1). The processor-based real-time simulation of components of the vehicle electrical system is made possible with the dSPACE **ASM Electric Components Library**. Synchronous motors can be connected to the FEM tool JMAG® to simulate nonlinear effects. The supported applications vary from electric drives and inverters for close loop control to complete automotive electrical systems including a battery, starter-generator, and alternator. Furthermore, control engineers can use the **XSG AC Motor Control Library** to access preconfigured implementations and engineering approaches for the development of drive control functions. >>

Figure 1: The HIL simulator can be used to access the electric motor ECU on different levels. Whether on the signal, power or mechanical level – dSPACE has a wide product range for each test case.



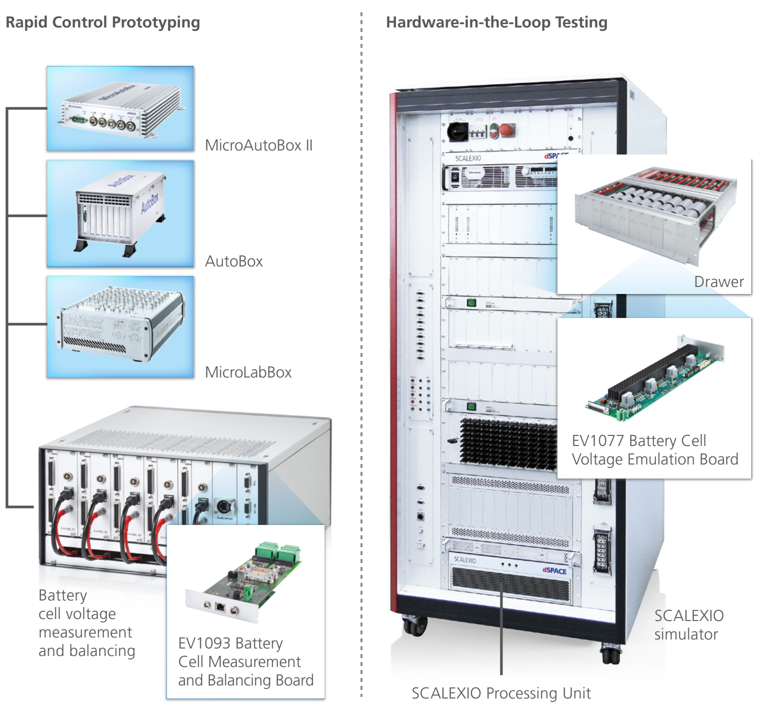


Figure 2: The products for battery management range from compact systems that can also be used in the vehicle to large systems for testing the entire vehicle.

Battery System

The battery management system (BMS) is a central component of every electric vehicle, because it maintains the battery performance during the entire battery life cycle. The BMS ensures that each cell voltage is in the optimum working range. dSPACE offers dedicated hardware for developing BMS functions, such as the **EV1093 Battery Cell Measurement and Balancing Board**. A single board can control up to 24 real battery cells. The more boards you use, the more battery cells can be controlled. The EV1093 can be used either in a laboratory system or in a vehicle with a suitable housing. To validate BMS ECUs, the HIL test system has to provide the simulated cell voltages and temperatures with high precision. The **EV1077 Battery Cell Voltage Emulation Board** makes it possible to inject voltages in the range 0 to 6 V. Damaged cells can be emulated in the same range as well.

Figure 3: The compact, robust housing makes RapidPro ideal for use in the vehicle, in the laboratory, and on the test bench.

Power Electronics

Power electronics are a key technology for electric vehicles. Some of the components used in electric vehicles are frequency converters for the electric drives, DC/DC converters for adjusting the different voltage levels and chargers for the interface between the power grid and the vehicle. To test these systems as realistically as possible, the test system must be able to respond in microseconds. For the fast and convenient development of functions for DC converters, dSPACE provides the **RapidPro system**, including a range of modules for configurable signal conditioning and power stages. During HIL tests, the **dSPACE Electrical Power Systems Simulation Package** enables the real-time simulation of topology-based power electronics models that were designed with Simscape Power Systems™ (Specialized Technology) by MathWorks®. The FPGA-based simulation has low latencies and supports step sizes of 2.5 µs. Preconfigured FPGA applications make it easier to start a project because they require neither FPGA-specific knowledge nor specialized software. More complex models can be split and computed on multiple processors or FPGAs simultaneously, so it is possible to simulate them in real time as well.

Electronic Auxiliary Units

In electric vehicles, all auxiliary units must be designed for operation with electric power. Typical units include electric power steering (EPS), electric brake systems, and electronic brake servo. Since these are safety-critical systems, mechanical tests are indispensable and must be performed in addition to tests at the signal and power level. dSPACE provides customizable **mechatronic test benches** that can be used to perform realistic test drives under laboratory conditions to test the behavior of the systems. With suitable simulation models, it is possible to test actuators for EPS applications under realistic conditions, for example. The dSPACE systems range from small rotary test benches for laboratory use, to large test benches for complete steering systems.

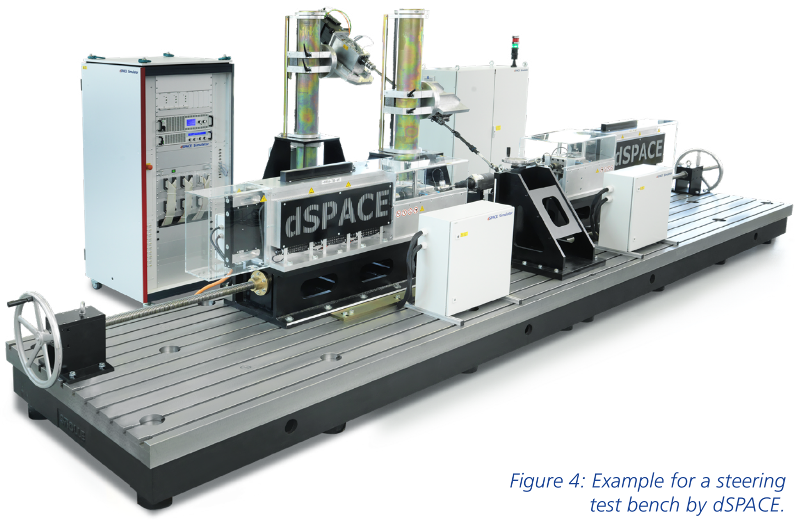


Figure 4: Example for a steering test bench by dSPACE.

More Information

For more example use cases with dSPACE products, go to *www.dspace.com/go/dMag_20181_emobility*

If you would like to learn more, you can request the dSPACE poster on electromobility: *www.dspace.com/go/sales*

Charging Stations

There are many different manufacturers of electric vehicles and the respective charging technologies on the world market. While the vehicle battery is charging, the vehicle and the charging station communicate to shorten the time required for charging and to exchange information, for example, on the technological fine-tuning between the vehicle and the charging station, on aspects of safety, and on payment options. Different standards apply to the charging technology in different regions of the world, e.g., CHAdeMO in Japan, ISO 15118 in Europe and the US, and GB/T in China. dSPACE offers solutions that can be integrated in the HIL test system and that help to test the different communication protocols.

Energy Generation and Distribution

Electromobility uses energy from a variety of sources, such as wind and solar energy as well as, for the time being, energy from conventional power plants. Coordinating the energy distribution is therefore becoming more complex, one reason being that energy from renewable sources is subject to daily and seasonal fluctuations.
To ensure a stable power grid, it is essential to precisely control the frequency and the power factor. The growing number of electric vehicles also imposes stricter requirements on energy management systems and the communication between them. With the dSPACE **Electrical Power Systems Simulation Package (EPSS)**, a wide range of energy generation and distribution systems can be simulated on the dSPACE systems. When used with the dSPACE RCP systems, the software package enables users to create a model-predictive control of an energy distribution system and simulate the entire energy system. ■

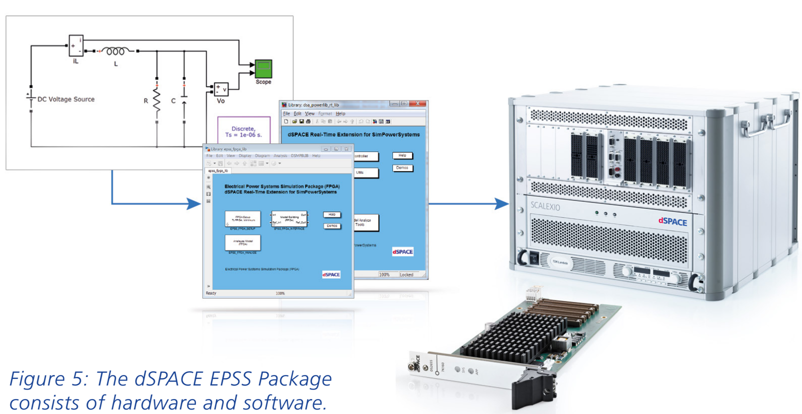


Figure 5: The dSPACE EPSS Package consists of hardware and software.