AVL High Performance Power-HiL™

Full test coverage for drive inverters makes the difference in power electronics testing

THE CHALLENGE

All high-voltage components in electric powertrains require dedicated testing methods and tools. Especially the traction inverter is a key component in electric propulsion systems as it controls all driving conditions and is part of safety-critical vehicle functionalities.

The demands on the inverter are versatile: it must be functional, safe, robust, compact and efficient when it comes to performance and cost. Power electronics combined with a high level of signal complexity, require an appropriate test methodology and the use of adequate testing equipment.

As the testing of the inverter requires the availability of the e-motor and its data, the inverter development doesn´t allow the simultaneous engineering of e-motor and inverter. Even the availability of good data is a limiting factor, as tests on mechanical testbeds are not possible without limitations or safety risks.

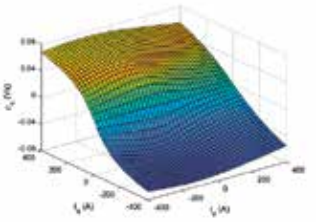
THE AVL SOLUTION

The AVL Power-HiL enables the validation of the inverter already in an early development phase and prepare its integration into the electrified powertrain. Frontloading of inverter tests drastically reduces the total test effort. This method allows testing of the inverter independent from the e-motor. It´s mandatory to design an efficient test environment for inverter testing, optimization and failure modes. Digital copies of the battery and the e-motor are necessary. The AVL E-MOTOR EMULATOR offers numerous functionalities and accurate reproducibility.

When it comes to transferring the characteristics of e-motors to the virtual world, there are three possible options:

- Linear e-motor parameters, including for example motor type and inductance, are available at an early development stage
- At a later development stage, a precise model is generated using the results of a finite element analysis
- Using data from the real e-motor tested on the e-motor testbed, an exact digital copy is generated

AVL has the right toolchain to support you in all of the aforementioned e-motor data scenarios. When it comes to linear parameters, AVL provides a validated linear motor model for each motor type. To translate the e-motor data into the AVL E-MOTOR EMULATOR, you can use different motor models as well as the Parameter Wizard. To measure electric motors, AVL delivers e-motor testbeds with pre-installed automated test runs. Here, the system identifies the flux linkage under current variations and generates maps accordingly (as shown in the picture).



Flux linkage of the q-axis versus current

Therefore, AVL can offer you efficient and flexible inverter test equipment, which emulates the real physics of an e-motor at the terminals.

The tests made possible by this equipment can be categorized into three groups:

- Basic functionalities: development and functional testing of single functionalities and optimization of control algorithms
- Qualification tests: thermal tests, level of efficiency, overload, active short circuit, control quality following different premises; evaluation of the inverter in a virtual vehicle
- Failure insertion tests: failure in rotor sensor, phase short circuits and disruption in the power unit, motor parameter deviations, mechanical failure

To execute complex and standardized test runs in a reproducible and efficient way, using an automation system such as AVL PUMA 2 Inverter is advisable, as you can now integrate additional measurement equipment, such as an electric power analyzer.

THE MAIN BENEFITS

In contrast to the conventional method of using an e-motor testbed in the inverter development, employing the AVL High Performance Power-HiL with an AVL E-MOTOR EMULATOR will give you a broader test coverage while simultaneously reducing cost and testing time. Compared to an active load emulator, the test results are based on the correct e-motor behavior without making any compromises regarding dynamics and emulator switching behavior. Thanks to the precise reproduction of the e-motor, you can achieve the same testing results as on a rotating testbed – extremely fast, reproducible and without any influential mechanical tolerances or safety-critical risks.

TECHNICAL DATA

UUT* DC-link Voltage in V	100 … 1,000
Number of phases	• 3 • 2x3 • 6
Phase current, 3 ph in A_{RMS}	up to 1,600
Phase current, 2x3 ph / 6 ph in A_{RMS}	up to 800
System power in kW	up to 1,000
Emulated motor types	• PMSM • IM • EESM
Additional control features	• Current control • Voltage control • Temperature dependency • Harmonics
Extensive functionalities	• Motor data generation • Motor data copy
Channels / number of UUT	• Single-channel (1 UUT) • Multi-channel (2 UUT)
Emulation via high performance power electronics	• 320 ns model • 800 kHz switching frequency
Failure insertion on power level	• Active shorts • Phase shorts • Phase breaks • DC breaks • Potential
Specific built-in tools	• Inverter protection • Signal scope • Parameter Wizard • Dedicated safety system

* UUT = Unit Under Test, e. g. inverter

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FIND OUT MORE

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