

Machine Emulator

Complete emulation of electrical machines



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Highlights

- Emulation of complex machine correlations without mechanical restrictions
- High-quality modeling of electrical, even not yet existing, machines (synchronous and induction machines)
- No risks through rotating shafts, vibrations and batteries in critical operation points
- Protection of inverter and test bench through parametrization of limit values
- Stable and intuitive control software
- Robust hardware design for 24/7 operation
- Efficient, bidirectional energy flow

Inverters are essential components in the electromobility sector as well as in numerous industrial applications. In the automotive sector in particular, the requirements made on quality, durability and safety are extremely demanding. In order for these to be secured, all components are subject to stringent test requirements, throughout development to production. Comprehensive test scenarios and independent component testing allow development costs to be reduced and innovations to be achieved faster. For thorough testing of inverters, it is necessary to extensively emulate the electric machine. Therefore the Scienlab Machine Emulator emulates the electrical characteristics of three- and six-phase electrical machines and enables an operation and testing of traction inverters independent of a real electrical machine.

Fields of application

- Characterization and examination of traction inverters
- Reproducible function test of inverters in various DC and AC boundary conditions and in case of machine faults
- Load and endurance tests and accelerated aging tests
- Emulation of high voltage and 48 V machines

The Scienlab Solution

The Scienlab Machine Emulator provides the facility for testing inverters comprehensively. Scienlab offers a complete inverter test bench from one single source as well as technical support and a know-how transfer for testing. At the Scienlab headquarter preliminary tests with the customer inverter are also possible. By using a Scienlab Machine Emulator the behavior of the emulator can be defined through individualized parametrization. In this way, one system can emulate different types of motors from various performance classes and designs, thus making time consuming and costly test stand conversion unnecessary. Combined with a Scienlab Dynamic DC Emulator it is possible to realize an intrinsically safe and completely parametrizable test bench, which enables a wide variety of tests ranging from reproducible function tests to safety-critical fault emulations that can be performed without real machines and batteries. The restrictions of a conventional mechanical test bench with rotating shaft, vibrations and torsional oscillations are made void.

Emulation of sensors

By means of the Scienlab Machine Emulator the following speed/position sensors can be emulated:

- Resolver (e.g. Tamagawa™)
- Sine-Cosine sensor (e.g. Sumida™)
- XMR sensor
- Hall sensor
- Incremental encoder

The emulation of two temperature sensors via analog signals is also possible. Different types of temperature sensors can be defined by look-up tables. The sensor emulator is also able to emulate sensor defects like phase shift and gain change of each sensor phase individually (asymmetry, eccentricity, gain fault, false direction), short circuit between signals or open terminals.

Integrated machine models

The model runs on the internal real-time processor of the Machine Emulator. The following machines can be emulated:

- Permanent magnet synchronous machine (PMSM)
- Asynchronous state machine with squirrel cage rotor (ASM)
- DC excited synchronous machine (DCESM)

The machine parameters can be defined as constant values or as 1, 2 or 3-dimensional look-up tables and the machine can be operated in speed or in torque setpoint mode.

External model connection for open machine model

Optionally an external calculation of the machine model in dq-synchronous coordinates can be used. This allows the customer to implement their own models (for example of six phase machines) on an external real-time system (e.g. FPGA) and to control the machine emulator as a flexible power stage. An example model for an external control via dSPACE FPGA Module is provided.

Intrinsically safe

The Scienlab Machine Emulator monitors its own state, currents, voltages and temperatures. The device under test is protected by additional parametrizable limits for over current, over power, over voltage and high speed (idling).

Emulation of line defects

With the Machine Emulator it is also possible to emulate short circuits and interruption (open circuit) of single lines on the machine terminal during operation, for example three-phase short circuit, two-phase short circuit via all three phases or one, two and three-phase failures.

Convenient control of the Machine Emulator

The Scienlab Machine Emulator needs to be parametrized with the data of the machine to be emulated (such as number of pole pairs, machine impedance, etc.) and the desired set points (speed, temperature, etc.) specified. Scienlab provides various options for the control and monitoring of the emulator:

- PC-based software Emulator Control for manual control
- Hardware-in-the-Loop systems (dSPACE, etc.), including model framework and graphical user interface for automated real-time testing
- Open interface for customized remote control (Ethernet or EtherCAT)

Technical Data of the Scienlab Machine Emulator

	48 V application	HV application
Power output		
Max. output power	±20 kW (up to four times parallel connection)	±160 kW (up to two times parallel connection)
Max. output voltage	70 V _{rms} (phase-phase)	560 V _{rms} (phase-phase)
Max. output current	420 A _{rms} (up to four times parallel connection)	600 A _{rms} (up to two times parallel connection)
Fundamental electric frequency	0...2.5 kHz	0...2.5 kHz
Basic voltage accuracy	<1 % full scale	<0.5 % full scale
Phase angle accuracy	<2° @ 2.5 kHz	<2° @ 2.5 kHz
Additional measuring channels		
	4 x current measurement inputs (for current transducers)	4 x current measurement inputs (for current transducers)
Measuring range	±1 A	±1 A
Measuring accuracy	<0.5 % full scale	<0.5 % full scale
DC option		
Max. output power	-	±180 kW
Max. output voltage	-	50...850 V
Max. output current	-	600 A
Cabinet information		
Basic dimensions (H x W x D)	2570 x 1600 x 800 mm	2450 x 3600 x 880 mm
Basic weight	1000 kg	1650 kg
Protection class	IP 54	IP 54
Environmental temperature	10...40 °C	10...40 °C
Humidity	30...75 % RH	30...75 % RH
Sound level according to DIN EN 3744	<70 dB(A), measured in 1 m distance on front	<70 dB(A), measured in 1 m distance on front
Cooling	Water cooling (optional air cooling)	Water cooling (optional air cooling)

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