

Lab-Based Simulation of Driver Inputs to Steering Systems

The MB Dynamics Steering Module Test Simulator (SMTS) technologies are used in the test lab to test and evaluate steering systems for: road-excited column and rack rattles; functional noises by repeat-ably controlling customer driving maneuvers; NVH issues (e.g. zipper noise); durability; and steering performance design verification. The SMTS is useful to vehicle OEMs and steering suppliers.

These non-hydraulic SMTS technologies are quiet (acoustically and electrically) to help troubleshoot, identify, diagnose, and resolve root causes of annoying noises and other such performance issues in EPS, EPHS, EPAS, MDPS, and HPS steering technologies. The SMTS simulates driver functionality and driving maneuvers (Driver Simulator) and simulates road and vehicle inputs (Rack Load Simulators) acting on the steering system. They enable experimental correlation of model predictions and validation of the power-assist control system and its transfer functions to help achieve objective and subjective NVH metrics and to characterize steering system sensitivity and performance.

The MB Driver Simulator uses closed-loop PC control of an electrical rotary actuator to generate repeatable and precise steering maneuvers of position / angle, angular rate, or torque using ASCII-imported time histories of measured drive files or user-customizable and software-based sine, triangle, saw-tooth, square, and trapezoidal waveforms.

The Driver Simulator includes: steering-specific software; slotless (no cogging forces) and direct-drive (no gears or belts) servo motors; drive amplifiers; absolute encoders; cabling; holding fixtures; and optional torque sensors – all tailored to customer requirements. The Driver Simulator applies these driver inputs through the steering column spline or directly to a steering wheel – in the lab or in-situ in a stationary vehicle.

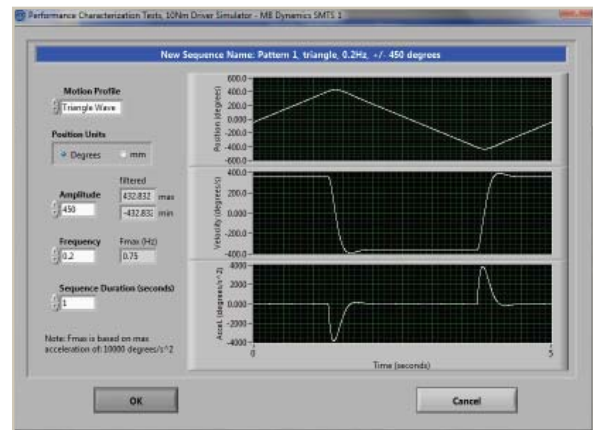
The Driver Simulator and SMTS software can be used stand-alone or in conjunction with Rack Load Simulators – electro-dynamic, electric, pneumatic and combinations. The Driver Simulator may also be used as a rotary exciter.

MB Driver Simulator Performance Specifications

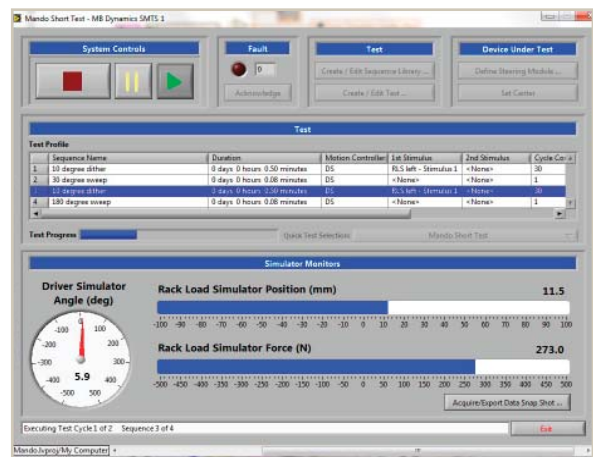
SPECIFICATION	DRIVER SIMULATOR MODEL		
	DS 10Nm	DS 25Nm	DS 50Nm
Continuous Torque, \pm Nm	10	25	50
Peak Instantaneous Torque, \pm Nm	40	100	200
Torque Resolution (with optional torque sensor), %	$\pm 0.1\%$ FS	$\pm 0.1\%$ FS	$\pm 0.1\%$ FS
Max Steering Angle, degrees	Unlimited	Unlimited	Unlimited
Angle Resolution, absolute encoder, pulses/rev	33.6×10^6	33.6×10^6	33.6×10^6
Max Steering Rate or Velocity, deg/sec. peak (rev/sec)	2,880 (8)	2,000 (5.6)	2,000 (5.6)
Angular Acceleration, bare rotor (no test item), deg/sec ² pk (rad/sec ²)	23,000 (400)	20,000 (350)	20,000 (350)
Rotary Inertia, bare rotor (no test item), kg-m ²	0.026	0.076	0.158
Nominal Steering Angle, lock-to-lock, deg	± 600	± 600	± 600
Nominal Time, lock-to-lock, sec	0.43	0.6	0.6
Performance with typical load of 0.025kg-m ² and 2.5Nm torque losses:			
0.5 Hz sine motion, deg	± 700	$\pm 1,400$	$\pm 1,500$
1 Hz sine motion, deg	± 200	± 360	± 420
5 Hz sine motion, deg	± 8	± 14	± 17
10 Hz sine motion, deg	± 1.5	± 3.5	± 4
Weight, kg	20	36	52
Input Power: 100 – 240 VAC, 50/60 Hz, single phase, kW	1.5	2	4

Other Key Specifications

- Background Noise (a measure of the Driver Simulator noise that can mask steering column/rack noises), no payload – no steering column/rack attached; 20Hz – 20kHz audio bandwidth; ¼ Hz sine waveform, ± 400 degrees: <30 dBA
- Waveforms Produced: ASCII-import of position vs. time or torque vs. time; sine; triangle; sawtooth; square; arbitrary
- Frequency Response: DC – 50Hz
- CAN Communications: SMTS and Driver Simulator can broadcast CAN messages every 2msec or 4msec
- Analog Output: position, rate, torque, current (any 3) via BNC
- Digital IO: 4 channels available
- Slotless Driver Simulator: no cogging or torque fluctuations because the stator is slotless; no cogging-related effects to create acoustic disturbances and contaminate waveform quality; smoother motion to steering column
- Frictionless porous-media air bearings, radial and thrust: no recirculating ball/roller disturbances; no friction; no contact; no wear; no lubricants; quiet; no oil; high accelerations; squeeze film damping
- Absolute encoder with photoelectric scanning; multi-turn; 33.6×10^6 pulses/rev effective resolution; EnDat 2.2; position available at power ON, no homing or finding a reference position
- Single axis digital servo controller with integral power supply, PWM amplifier and position controller in a single package; host-mode operation uses PC commands sent via Ethernet or USB for immediate execution; SMTS uses multiple networked drive amplifiers controlled from one PC
- (Optional) Rotating Torque Sensor (contactless); \pm static and dynamic measurements; accuracy $\pm 0.1\%$ FS; $\pm 10V$ torque output; max torque 200% safe overload; supply voltage 12 – 28VDC; bandwidth 3kHz



SMTS, CREATE SEQUENCE SCREEN



SMTS, RUN TIME SCREEN

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