TECHNOLOGY, TEST PROCESSES & ENGINEERING SERVICES

MB Dynamics

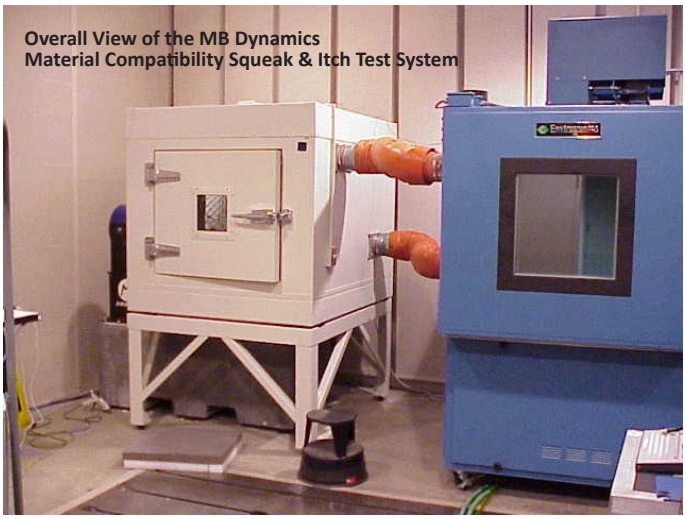
Material Compatibility Squeak & Itch Test System

Functional Performance Specifications

Automotive *squeaks* occur when materials in contact rub against one another causing annoying noises from friction-induced stick-slips.

Automotive *itches* are a special category of noise that can develop when rubber or plastic rubs against glass or paint.

The MB Dynamics Material Compatibility Squeak & Itch Test System is designed and manufactured to subject contacting pairs of materials and actual vehicle parts to precisely controlled interference and motion under in-vehicle environmental conditions in order to acquire, monitor, analyze and report friction and acoustic characteristics with the objective to:



Overall View of the MB Dynamics Material Compatibility Squeak & Itch Test System

- Better understand material compatibility
- Find material combinations that perform best over a broad range of conditions
- Troubleshoot existing squeak, itch and material compatibility problems
- Benchmark competitor material pairs
- Evaluate effectiveness of coatings and material blends
- Correlate to friction math models to predict material compatibility performance
- Identify material properties and system parameters that are good predictors of noise generation tendencies

System Setup
- Configuration and .ini files
- System setup page
  - Engineering Units; Conditioning Module setup; Sample height – define and measure on site; System folders; Default report template

Channel Setup
- Explanation of why you may want multiple channel setups (i.e. Load cells-no load cells)
- How fields are assigned and where they are used (labels, sensitivity and units)
- How to load, create, edit, and save channel setup files
- Setup Description

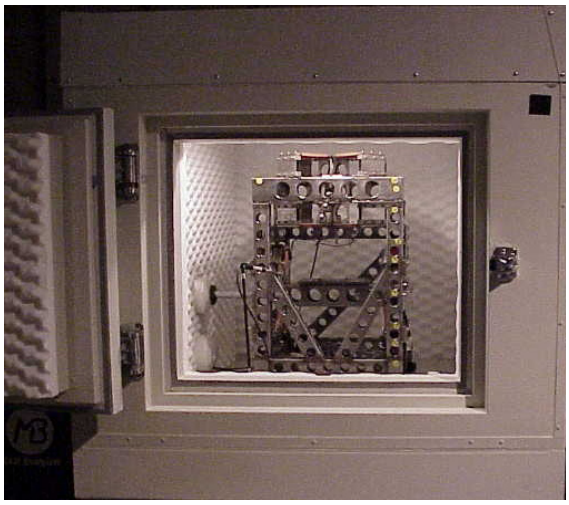
Profile Setup
- Profile Types:
  - Sine Profile: Swept Frequency; Ramped Amplitude (closed loop); Ramped Amplitude (open loop); Constant Amplitude
  - Push Pull: Single Push; Single Pull
  - Random
  - Time History
- Data Collection Options:
  - Acoustics (S&R Metrics software package and recording sound; Acoustic parameters/metrics [SPL/Sones])
- Channel data (stroke, velocity, force)
- Shaker and profiles limits
- Load, create, edit, and save profile files

Test Setup and Operation
- Screen layout
- Channel Overload area (purpose and reset button)
- Test setup extra info option
- Dynamic measurements (graphs) vs. static (numeric boxes)
- Status window
- Loading Test setup files:
  - Uses graphs to verify sensor functionality
  - Setting Force/Offsets (manual vs. automated)
- Running a Pretest:
  - Purpose of pretest; Determine and adjust reference voltage (dynamic range optimization); Noise floor measurements and meaning
- Running the Test sequences
- Advanced Options (Scheduler, Random Profiles)
- Load, create, edit, and save test setup files

Report Generation
- Open and demonstrate existing reports
- Create new reports
- Advanced Options (labels and multiple data files)

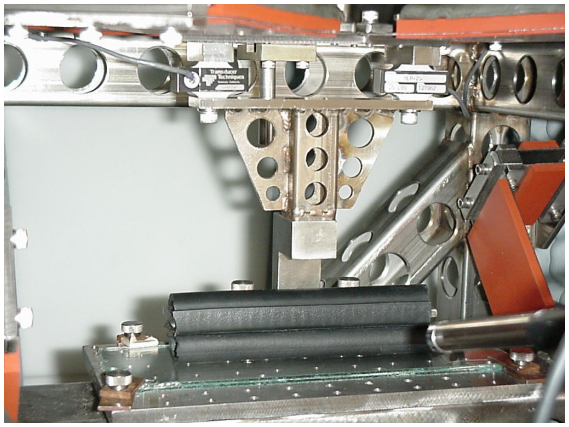
Performance Specifications for Major Deliverables

Material Compatibility Controller and Software. Controller-software acquires, records and archives acoustic time histories (sound pressure and Zwicker loudness); normal force and friction force between materials during controlled motion; displacement, velocity, and acceleration from any controlled motion; interference (negative gap between mating pairs); temperature and humidity inside Quiet Chamber during a test; date and time. Sampling frequencies for friction measurements are at least 6 kHz and for acoustic measurements are 44.1 kHz. Controller-software controls single excursion movements (push/pull) of mating pairs for friction measurements; fixed amplitude, variable frequency sine sweeps; fixed frequency, variable amplitude sine ramps; random vibration using PSD's; and time domain waveform replication of in-vehicle measured drive files of at least 20 seconds duration. Controller provides 8 input channels including sound data acquisition and uses serial links to control Environmental Conditioning Module to maintain set point temperatures and humidities inside Quiet Chamber. Report writer provides for user-customized reports with text and graphics including coefficient of friction and other traditional friction parameters. Data exported in ASCII and .WAV formats to support further analysis.



Quiet Chamber with apparatus inside

Precision Apparatus to Fixture, Position and Move Specimens. Apparatus has minimal friction and no stiction that can contaminate friction force measurements over the temperature/humidity conditions described below. It has minimal noises generated during any of the prescribed environments and controlled motions. Instrumentation measures normal and friction forces during single excursion tests. Normal force values to be used for testing purposes do not exceed 20N. Range of motion for single excursions are 25mm peak-to-peak. When force measurements are not needed, it is easy to remove the force transducers. It is possible to fixture either flat samples of material pairs or actual car parts (molded rubber parts, glass, painted metal, plastic trim pieces, etc.) The apparatus provides for automatic set-up of normal force or interference (prescribed positive or negative gap between mating pairs) from outside the Quiet Chamber with the door closed. Apparatus has minimal cross-axis motion to minimize unequal velocities across specimen surfaces and to assure flat specimens stay in full contact during a test. Fixtures are provided for flat specimens. Apparatus has its own supporting base separate from Quiet Chamber. Transducers are calibrated in-situ to minimize contamination of background noise levels. Apparatus has self-aligning mechanism to assure maximal surface contact between mating materials under test. This mechanism functions over the full normal force range of the machine.



Close up of Weatherstrip Test

Transducers and Signal Conditioning to Measure All Parameters acquired by Controller and Software
(friction force, normal force, sound pressure, displacement, velocity, acceleration, interference, temperature, humidity)
Temperature-insensitive mounting arrangements for each transducer are provided turnkey, including microphone. Calibration kit, software and written procedures are provided for all transducers that must be calibrated in-situ or with their signal conditioning. MB assures that a microphone provides predictable performance at cold temperatures.

Quiet Exciter and Power Supply. Capable of N10 Loudness background noise level of 1.5 sones when performing a 0.3 gRMS typical squeak & rattle test from 8 Hz to 100 Hz. Range of motion for single excursions are 25mm peak-to-peak. Operates from DC to 1,000 Hz.

Quiet Chamber *(doubles as an Environmental Chamber).* Encloses the Apparatus to create a quiet environment for specimen testing. Background noise level inside Quiet Chamber shall not exceed 27 dBA in accordance with GM9842P when performing tests as required therein. (User must provide ambient lab noise conditions of not greater than 55 dBA. In this environment the background noise is less than 20 dBA with nothing moving inside the Quiet Chamber – At Rest, Ready.) Quiet Chamber is physically separate from the temperature & humidity conditioning module to minimize acoustic contamination caused by noises from condenser coils. Quiet Chamber is structurally isolated from the Apparatus, Quiet Exciter, lab facility, etc. in order to minimize acoustic contamination from structure-born and air-borne sources emanating from outside the Chamber. Quiet Chamber is able to maintain internal air temperatures from – 40°C to + 50°C and 10% to 95% RH as supplied by the Remote Conditioning Module. Internal wall surfaces are acoustically treated to minimize reverberant noises, as a further strategy to achieve the 27dBA.

Temperature and Humidity Conditioning Module. The moduel is located remotely from the Quiet Chamber to minimize acoustic contamination caused by noises from condenser coils, but with short interconnecting ducts to minimize thermal losses. Module produces conditioned air from – 60°C to + 150°C and 10% to 95% RH. Environmental Conditioning Module is controlled over serial links from the Controller to maintain set point temperatures and humidities inside Quiet Chamber.

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