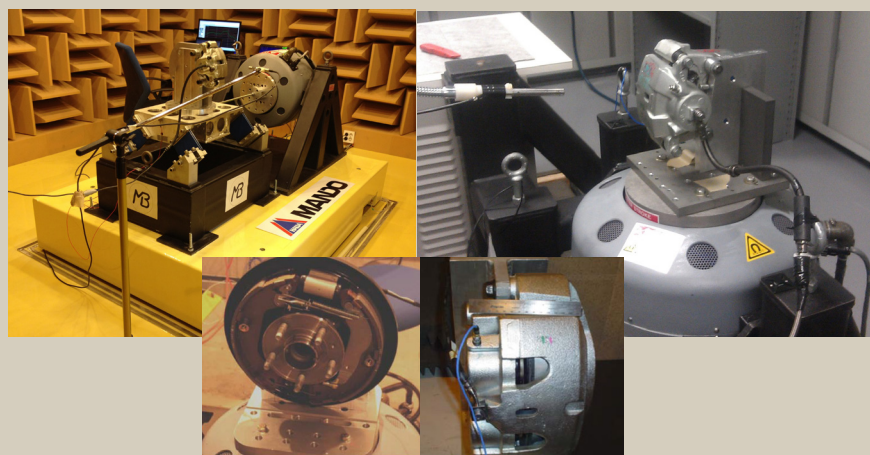


MB BRAKE RATTLE DETECTOR

OBJECTIVE BRAKE ASSEMBLY & COMPONENT RATTLE TEST RIG



MB Brake Rattle Detector is a quiet, non-hydraulic lab test system that subjects brake assemblies and components to in-vehicle vibrations sequentially in multiple directions.

The system also objectively measures and quantifies brake rattle performance so that effective corrective actions can be evaluated and implemented.

GMW16316 Test Procedure Objective Brake Component Squeak & Rattle Test

GMW14011 Test Procedure Objective Subsystem/Component Squeak & Rattle Test

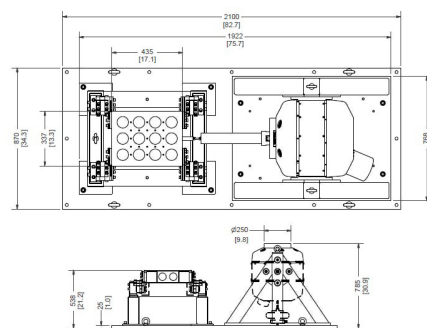
*Adheres to GM Requirements for Test Improvement
Process Accreditation of non-GM Brake Lab Test Facilities*

Jobs to be Done

- Implement a lab system without hydraulics that quietly and repeatably reproduces road load inputs to brake caliper assemblies (pads & hardware), drum brake assemblies, splash shields, multi-piece rotors
- Acquire and analyze objective acoustic measurements during lab tests using Zwicker Loudness and other NVH metrics to evaluate the rattle performance of brake assemblies and components
- Characterize root sources of noises such as caliper pin-to-bore contact, influence of running clearances and tolerances, drum brake shoe and lining contact, rattles with and without brake pressure, rotor disk to rotor hat contact, pad-to-abutment contact, splash shield to knuckle contact, etc.
- Assess corrective actions quantitatively & objectively, not just subjectively
- Evaluate performance of new brake assemblies, those with use after accumulating equivalent kilometers (life cycles), and those after durability tests
- Test all passenger car and light truck front/rear brake components

Objective Brake Component Rattle Test Rig

- S&R Energizer SILVER Vibration Exciter System with Load Support for Vertical Excitation, referenced in GMW16316, GMW14011 and TIP
- Horizontal Moving Table (HMT) for Sequential Fore-aft & Lateral Excitation when connected to SILVER, as referenced in GMW14011
- Millenium™ Hawk PSD Random, Time History, and Sine Vibration Controller
- Acceleration Sensor
- BSR SUITE™ Acoustic Data Acquisition and Audio Processing Software, complies with DIN45631/A1, comparable to Head Acoustics Artemis
- Equipment is capable of quietly exciting a large payload, such as a truck front brake caliper assembly and fixture weighing 25 kg, to a high excitation level, such as the 35 m/s² and 40 mm p-p that occurs in the vertical direction on some very rough test track surfaces
- Note: Requires end-user to supply qualified quiet room, test items/fixtures, brake apply system for supplying hydraulic brake pressure, and brake hose retention system



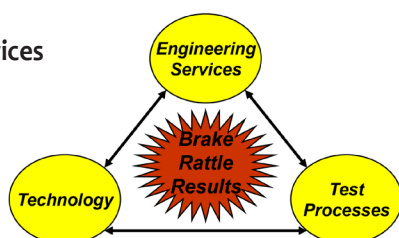
PNEUMATIC / ELECTRICAL SPECIFICATIONS

FACILITY REQUIREMENTS:
SEE ASSOCIATED SYMBOL FOR POWER DROP LOCATION.
LOCATION #1

ELECTRICAL (CABINET):
200-480 VAC, 50/60 Hz, 1Ø / 3Ø, 7 kVA (SEE GENERAL NOTES FOR DETAILS)

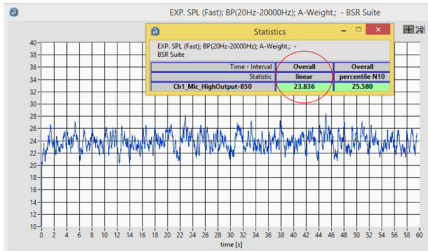
PNEUMATIC (AIRSPRING UNDER ENERGIZER)
FILTERED COMPRESSED AIR, 100 PSI @ 2.5 BAR @ 30 LITERS / MIN (30 PSI @ 1 CFM)
(MUST CONNECT TO "F" FEMALE NPT QUICK DISCONNECT ON REAR OF CABINET.)
-USE RABBIT "N" X "N" FEMALE - "N" MALE NPT TO "N" RIG PARKER 1/4" (1/4" FEMALE - "N" MALE NPT TO 1/4" INCH) OR SIMILAR TO MAKE CONNECTION IF NEEDED - NOT SUPPLIED.

MB Engineering Services Support Rattle Tests

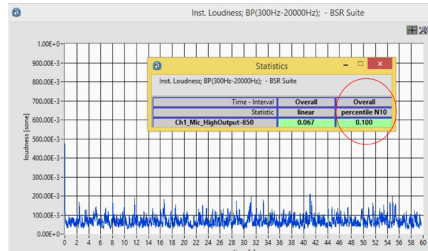


Quiet Energizer MB SILVER Exciter and Amplifier

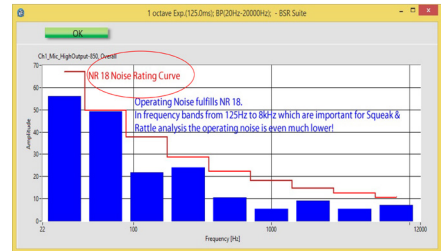
Metrics used to describe quiet operating background noise of SILVER running typical S&R test 0.3gRMS, 5 – 100Hz



Sound Pressure Level: 23.8 dB(A)



Instantaneous Loudness: 0.1 Sone N10



NR 18 Noise Rating Curve

Quiet Energizer

MB SILVER Exciter & Amplifier

- Air spring load support re-centers payloads up to 90kg
- Stiff load support inside SILVER resists large moments and offset loads from brake assemblies and fixtures
- 1,550N RMS during PSD random vibration without cooling
- High-fidelity reproduction of PSD random, time history & sine tests
- Frequency response: DC - 1000Hz with air spring load support
- Stroke: 40 -- 45mm p-p (50mm between mechanical stops)

Test Condition	Loudness, Sones N10
At Rest, Ready to Shake (no shaking, qualifies test cell)	0.53
Background Noise per GM14011, shaking, fixture only, 8 – 100Hz, 4.13m/s ² RMS (qualifies test rig)	0.96
Operating Noise, shaking, simulated test item and fixture, 32.3 m/s ² RMS, 40mm p-p brake test	2.51

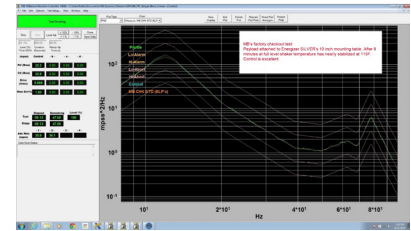
Horizontal Moving Table

- Connects to Energizer SILVER for sequential horizontal vibration in fore-aft & lateral directions
- Moving table has precise linear motion with minimal cross-axis response in rattle bandwidth
- Frictionless and noiseless motion – no oil, pumps, bearings, or rolling elements – uses patented flexures for support
- Test items: 500 mm X 500 mm footprint



MB Millenium™ Vibration Controller

- 4-Channel Input MB Millenium Hawk Shaker Control
- PCIe DSP board and interface cable to ADC/DAC/AAF interface unit
- Interface unit has built-in low impedance (IEPE-type) current source & voltage inputs
- PSD Random, Sine and Time History Control Software
- Windows 7 64-bit rack-mount or desktop PC



Quiet SILVER Performing Brake Tests

- Energizer Silver electrodynamic exciter (*not hydraulic*)
- Quiet Package - no exciter noise, no cooling system, no blower

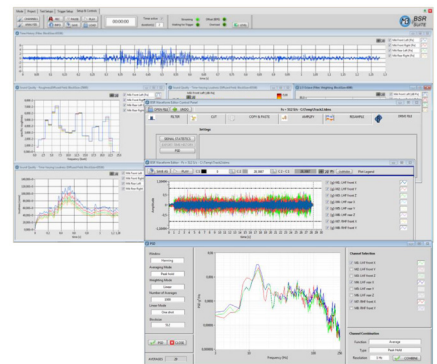
Objective Noise Measurement Using BSR SUITE™ Measurement System

Designed for

- Road load data acquisition
- Drive-File generation for single- and multi-axis shaker test systems
- Objective Squeak & Rattle testing
- Sound Quality testing of functional noises (annoying noises)
- Sound & Vibration measurements
- Measurement of relative motions

Features:

- 4 to 64 dynamic input channels
- Simultaneous 24-bit A/D converters
- Flexible sample rates up to 105.4 kHz
- 4mA IEPE-supply, software switchable
- Signal statistics (rms, peak, percentile levels)
- Predefined setups for typical S&R tasks and test specifications
- Real-time Sound & Vibration testing against user selectable thresholds
- Offline data processing, playback and export



BSR SUITE™ for Loudness per GMW14011

- Comprehensive signal processing and analysis: different filters, weighting, integration and various analyses such as Running RMS, Leq, Lpeak, FFT, PSD, 1/n Octave Band Spectra and Time-Varying Loudness
- Time Varying Loudness with optional Adaptive Background Noise Compensation enables automatic compensation of stationary signal components & improves correlation to subjective loudness perception of Squeak & Rattles
- Sound Quality analyzes for objective evaluation of functional or operating noises (seats, sunroofs, looking noises, etc)
- Signal statistics & testing against user defined thresholds enables objective S&R and Sound Quality testing, real-time.

