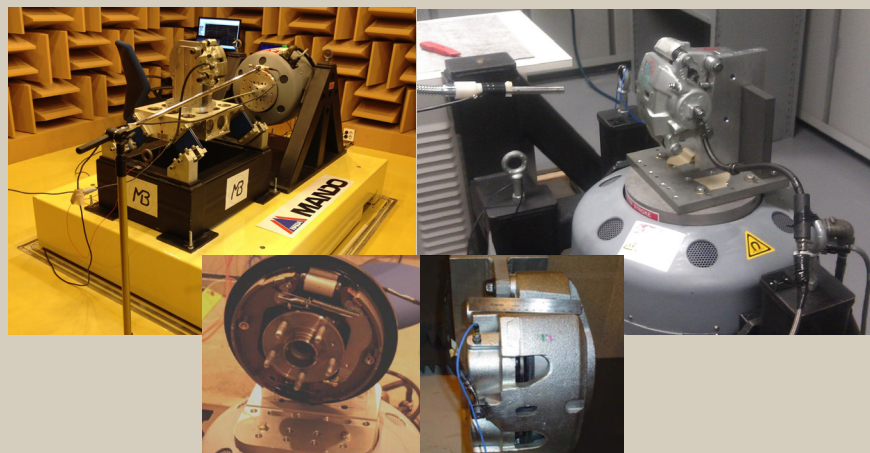


## MB BRAKE RATTLE DETECTOR

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

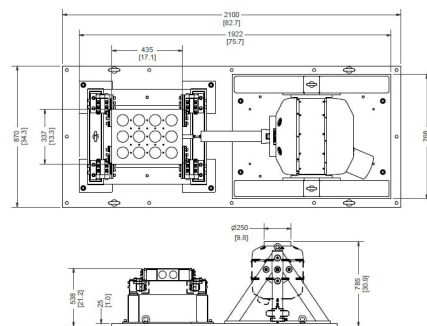
*Adheres to GM Requirements for Test Improvement  
Process Accreditation of non-GM Brake Lab Test Facilities*

#### 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/s<sup>2</sup> 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



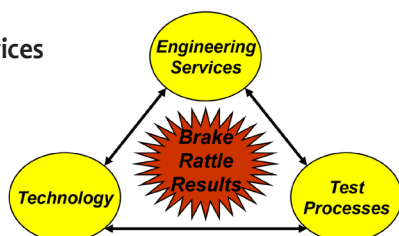
#### PNEUMATIC / ELECTRICAL SPECIFICATIONS

**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)

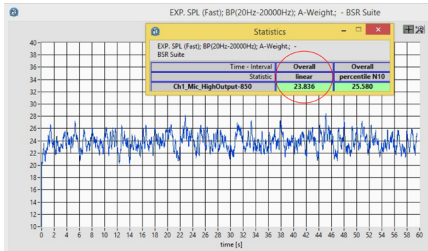
**PNEUMATIC (AIRSPRING UNDER ENERGIZER)**  
FILTERED COMPRESSED AIR, 100 PSI / 7 BAR @ 30 LITERS / MIN (30 PSI @ 1 CFM)  
(MUST CONNECT TO "F" FEMALE NPT QUICK DISCONNECT ON REAR OF CABINET.)  
-USE RABBIT "N" X "N" FINGA - "N" MALE NPT TO "N" RIG PARKER 1/4" (1/4" FINGA - "N" MALE NPT TO 3/4" IN.)  
ON SIMILAR TO MAKE CONNECTION IF NEEDED - NOT SUPPLIED.

### MB Engineering Services Support Rattle Tests

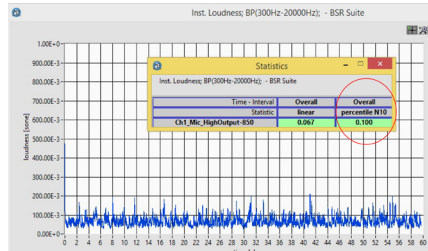


## Quiet Energizer MB SILVER Exciter and Amplifier

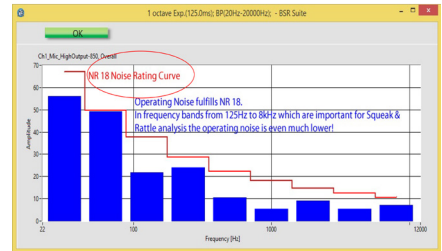
Metrics used to describe quiet operating background noise of SILVER running typical S&R test 0.3gRMS, 5 – 100Hz



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 <sup>2</sup> RMS (qualifies test rig)	0.96
Operating Noise, shaking, simulated test item and fixture, 32.3 m/s <sup>2</sup> RMS, 40mm p-p brake test	2.51

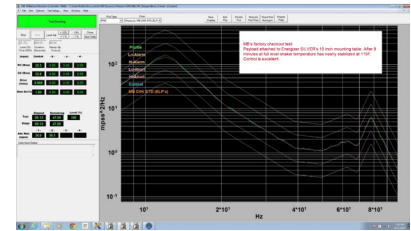
### Horizontal Moving Table

- 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

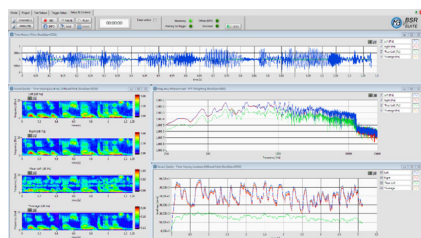
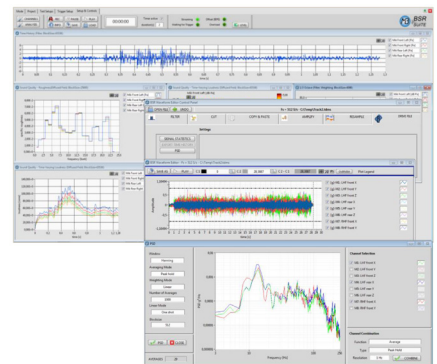
### Objective Noise Measurement Using BSR SUITE™ Measurement System

#### 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.