MB Dynamics
TECHNOLOGY, TEST PROCESSES & ENGINEERING SERVICES

Innovative, Proven Full Vehicle BSR Technologies

Effective, Lower-Cost, Quieter Excitation of Squeaks & Rattles

Squeaks & Rattles (S&Rs) are annoying noises that cause customer dissatisfaction, high warranty costs, and poor quality. The J.D. Power Initial Quality Study℠ (IQS) surveys owner-reported problems in the first 90 days of new-vehicle ownership. Body & Interior Quality - Mechanical scores issues including poor interior fit & finish and squeaks & rattles. IQS findings command worldwide attention. Media inform consumers when OEMs fall short: "We get downgraded because of little things like a squeak or a loose part." As such, OEMs and suppliers welcome technology to help them design & build noise-free vehicles. MB Dynamics delivers effective, low-cost, quiet excitation technology to root source S&Rs in vehicles, trimmed bodies, subsystems and components. MB's patented Direct Body Excitation (DBE) Road Simulator and Dynamic Vehicle Twist (DVT) technologies help detect vehicle S&Rs during development, launch, and production. Electrodynamic and pneumatic excitations under PC control replace hydraulics.

FULL VEHICLE BSR TECHNOLOGIES

INSTALLATIONS

BMW
Dingolfing Plant, End-of-Line
Dingolfing Plant, Quality

GM
Lansing Plant, Quality

Mercedes
Sindelfingen Plant, Quality
Bremen Plant, Quality

Hyundai
Seoul, Development
Ulsan Plant, Quality
KMC Plant, Quality

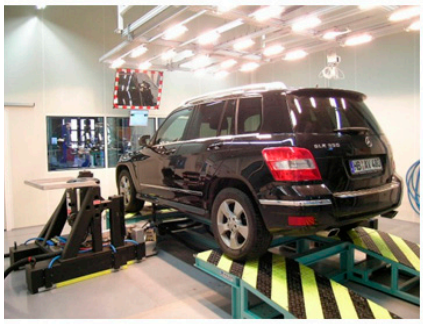
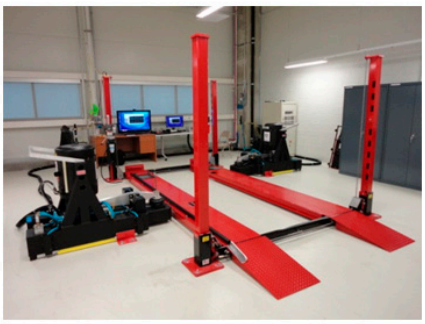
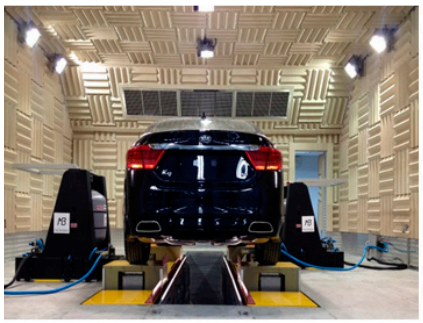
PSA
Brazil, Development

Volkswagen
Chattanooga Plant, Quality

Tesla Motors
Fremont, Development

CATARC
Tianjin, Development

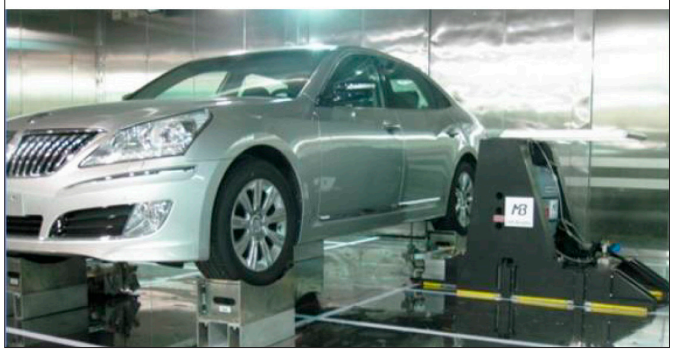



CUSTOMER TESTIMONIAL: *"Your team has done an excellent job in putting together a viable S&R assessment/root cause determination tool. We have the potential to significantly reduce the root cause/source determination of squeaks and rattles. This will result in a better quality product and higher levels of customer satisfaction. I can see significant improvements concerning (1) redundant S&R road testing, (2) time required for rapid and accurate S&R assessments and corrective action determination and validation, and (3) enhanced end-of-the-line throughput to name but a few."*

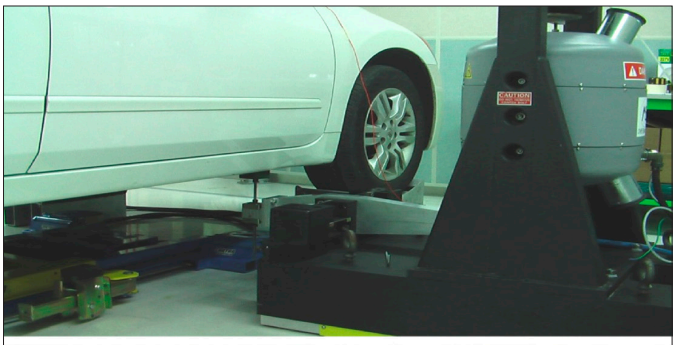
DBE TECHNICAL SPECIFICATIONS

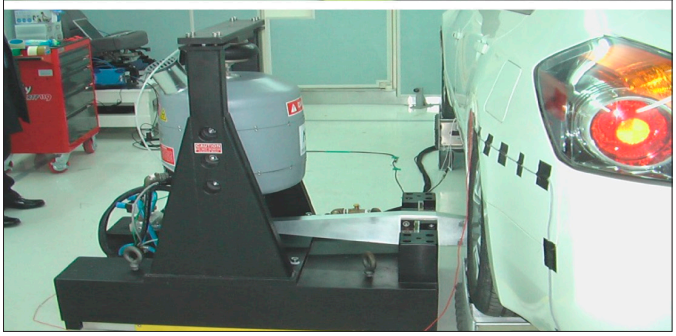
- Quiet (30 dBA inside vehicle running drive file, not connected to vehicle); no wheel pan slap; no tire noise; no servo-valve hiss; doesn't mask BSRs
- Higher frequency energy (up to 200 Hz) excites BSRs not found with road simulators (< 70 Hz)
- Requires no seismic mass; minimal disruption to facility; minimal facility cost; pit optional
- Cost is 1/3 to 1/2 that of a Hydraulic 4-Post Road Simulator
- Safe use; no high pressure oil; no disposal/environmental issues
- Low maintenance; simple operation for plants/labs
- Road-load time history, road-measured PSD random vibration, sine vibration
- MIMO control of each of 2 DBE Energizers, different drive files, front and back
- Quiet, therefore feasible & preferable to use for objective measurements (low background noise)
- Direct coupling to vehicle allows realistic reproduction of various recorded road excitations with relatively small forces; not damaging to paint
- BSR detection effectiveness > 90% with 2 Energizers
    - *number based on 6-month study by Daimler*
    - *confirmed by other customers*
    - *more improvement possible with 4 Energizers*
- Safe operation enables effective BSR analysis on interior, exterior and underneath
    - *car is standing on its wheels*
    - *no handling or control needed (hands free)*
    - *safe to move inside vehicle during excitation*
    - *safe to get in and out; multiple people*
- Realism generates high acceptance; physically feels like and audibly sounds like riding on the road
- Used in factory, quiet room, environmental chamber (-40°C to +60°C) or in combination with sun simulation systems

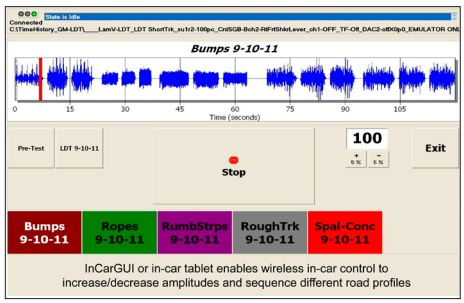


DIRECT BODY EXCITATION (DBE)

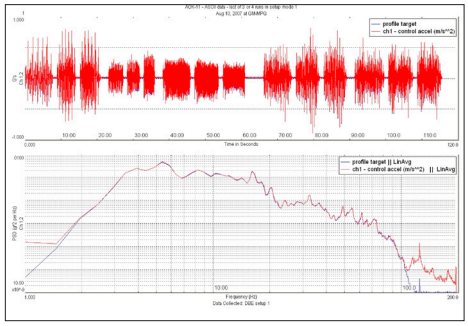
DBE Technology is a quiet and cost-effective alternative to hydraulic 4-posters. Quiet Energizers from MB can be installed in an environmental chamber (Mercedes and Hyundai)



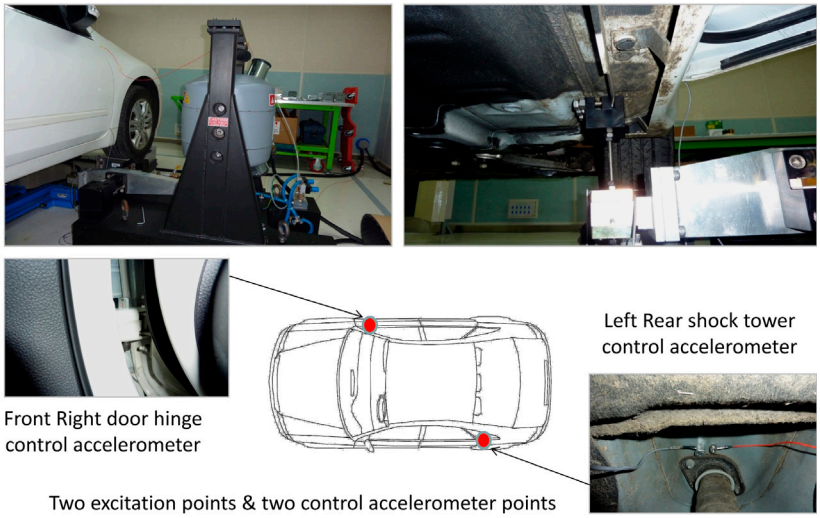




TIME HISTORY CONTROL

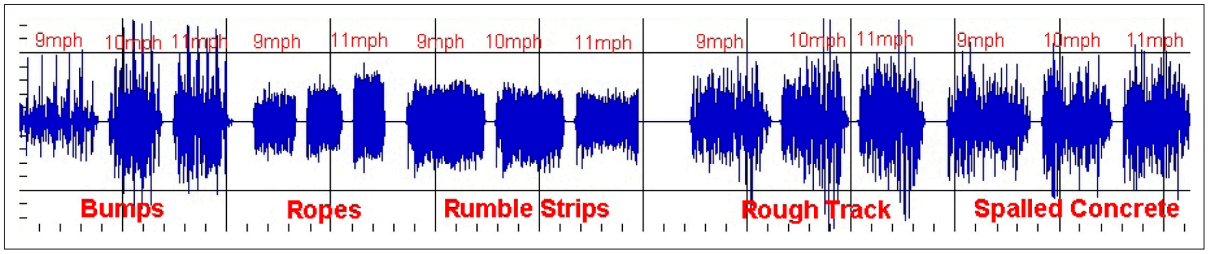


COMPARING TIME HISTORY CONTROL



CUSTOMER TESTIMONIAL: *"The new interface, which allows the plants to select any portion of the test that they wish to run, or the entire test, is a big time saver and provides really good results. The 9, 10 and 11 mile variations was surprisingly impressive. Giving the plants the ability to adjust the amplitude to > than 100% was another nice bonus that will also help in root cause analysis. All told, I think we definitely have a solid piece of equipment that will help us improve the quality of our vehicles."*

CONTROLABILITY AND ROAD SIMULATION



- Replicate real driving conditions using proving ground surfaces, assembly plant tracks, and local S&R roads
- Control to acceleration time histories, PSD random spectra, speed sweeps from 0–25 mph/kph, sine vibration
- Reproduce random-like vibration, chuckhole-type transient events, periodic inputs, & speed-dependent inputs
- Use remote control mouse from inside the vehicle to repeat road surfaces over & over to identify root cause (s)
- Vary amplitudes from 25% to 150% of recorded accelerations to find/fix amplitude-dependent S&Rs
- Sequence, then link, different roads into corporate test procedures or vehicle-specific excitation conditions

REMOTE TABLET

Remote Tablet enables full control over all setting and displays at any time inside vehicle. Direct network connection over WLAN (preferred, no router required) or VPN (long distances). Remote Tablet can also be used for remote control of MB Vibration controller.

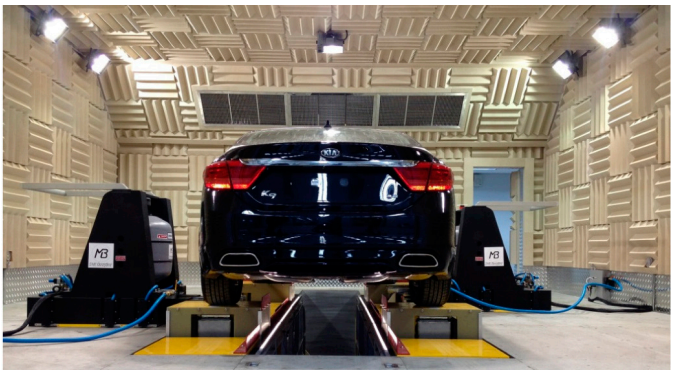
Remote Tablet

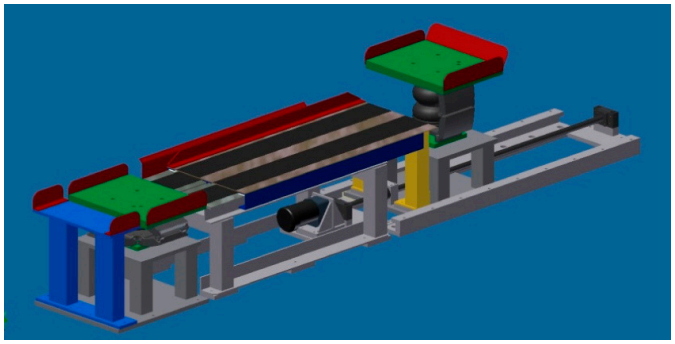
Laptop or Desktop PC

FULL VEHICLE BSR TECHNOLOGIES
DYNAMIC VEHICLE BODY TWIST (DVT) or TORSION SIMULATION SYSTEM FOR BSR

DVT FOR LARGE VEHICLE TWIST DISPLACEMENTS

- Dynamic body twist or torsion from long-stroke, low-frequency motion through the wheel & suspension: simulates twist ditch circuit & low-speed curb impacts
- Excites suspension & mount noises, rubber & seal itches, and body creaks
- Twist Sine, Single Wheel Lift, Pitch Bumps, User-defined
- 0 – 2 Hz Frequency Response
- Air spring actuators provide 150mm peak-to-peak of stroke under each wheel
- < 60dBA outside vehicle during DVT moves
- MIMO control of each of 4 wheels, controls displacement amplitude, shape and phasing
- Wheel pans support vehicle during DBE
- Front wheel pans move for various wheelbases
- Wheel pans wide enough for all tracks





DVT FOR LARGE VEHICLE-TWIST DISPLACEMENTS

WHEEL PAN WIDTH	DISTANCE BETWEEN WP	CLEARENCE TIRE-WP GUARD	TIRE SIZE	TIRE WIDTH
660.4	1046.80	25	145	145.0
660.4	1046.80	25	155	155.0
660.4	1046.80	25	165	165.0
660.4	1046.80	25	175	175.0
660.4	1046.80	25	185	185.0
660.4	1046.80	25		
660.4	1046.80	25		
660.4	1046.80	25		
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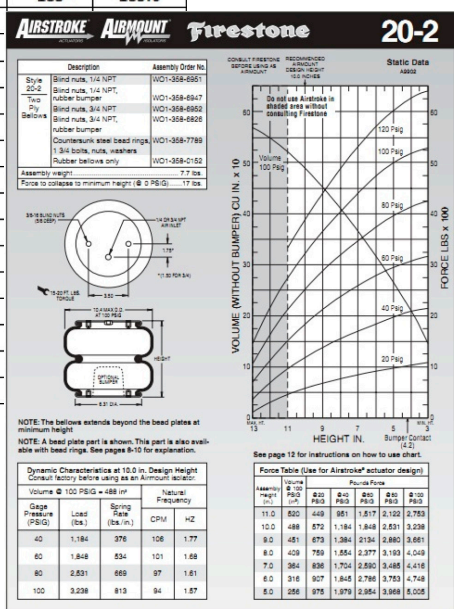


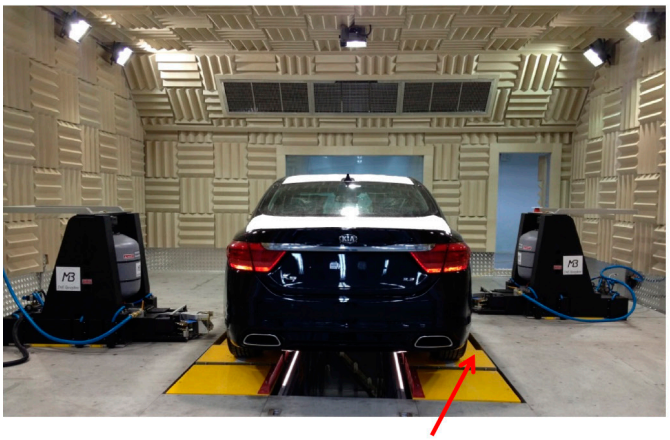
DVT RANGE OF TIRE & TRACK DIMENSIONS FOR VARIOUS VEHICLES - WHEELBASE OPTIONS

Freq, Hz	Dead Wt., 500kg	Weak Suspension *	Stiff Suspension *
0.25	150mm	150mm	75 – 125mm
0.5	125mm	125mm	50 -- 100mm
0.75	100mm	100mm	40 -- 60mm
1.0	75mm	75mm	20 -- 40mm
1.5	50mm	50mm	20 -- 40mm
2.0	25mm	25mm	10 -- 20mm

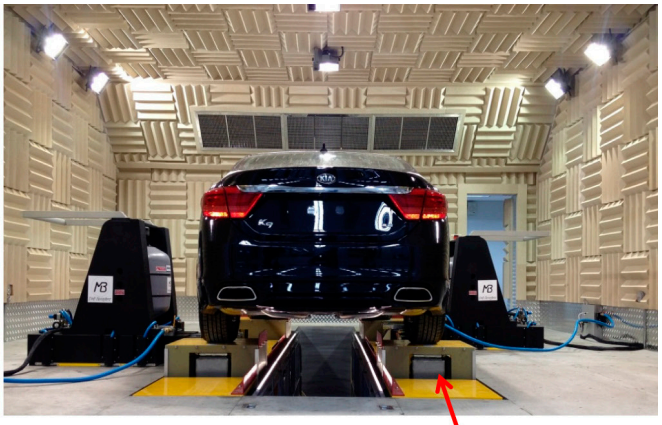
DVT FREQUENCY / DISPLACEMENT & PAYLOAD

* Displacements for different “payloads” or “Suspension” values depend on a vehicle’s suspension stiffness/ damping characteristics, desired test displacements, and air flow rates and air line pressures available. Displacements must be iterated upon and tailored to the vehicle-under-test considering safety considerations and risk of overturning.

DYNAMIC VEHICLE TORQUER DVT + DBE



DVT Wheel stands in DOWN position
for DVT



DVT Wheel stands locked in full UP position
to support vehicle during DBE

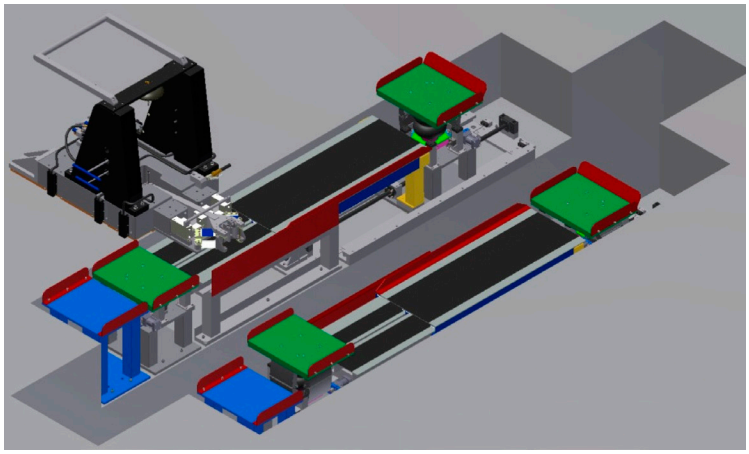


ILLUSTRATION OF THE DYNAMIC VEHICLE TORQUER - DVT + DBE

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