

NVH Testing for Improving Door Quality

NVH Engineering focuses on improving the quality of the users experience by modifying the noise, vibration and harshness of the vehicles. A vehicle's noise and vibration characteristics are becoming more important with the rise of the electric vehicles. NVH affects ride quality, drivability, and occupant comfort. Interior or exterior NVH measurements are both required to improve the car quality.



EZMetrology has been following the market trends and has been actively working with NVH departments at OEMs to improve their door and vehicle quality. Today EZMetrology offers a range of products applicable or dedicated for NVH studies. In this application note, solutions are sorted from technicality based on the testing requirement.

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A. Single Speed Recording

A.1 EZSpeed - Stand Alone Mode

EZSpeed can be used to record an instantaneous speed of the door. This is essential metric to include in the door sound measurements. EZSpeed will be able to document the impact speed of the door for every single test. To eliminate the device sound on the door, it can be mounted on a separate tripod, and therefore have no influence on the sound signature. The target, that is used in production environment to increase mounting tolerances, is not required as the system can be easily monitored in audit environment. The speed, that is shown on the large screen, can be manually recorded, and documented with our Audit Software. This technology is applicable to any door style (pivoting, sliding, liftgate, hood, trunk, frunk, etc.).



EZSpeed placed on a car.



EZSpeedBox set up on tripod.

A.2 EZSpeedBox - Wired

EZSpeedbox is based on the similar laser technology as EZSpeed, providing an instantaneous speed of the door at a given position. The result can be communicated over USB, recorded on a computer, and logged in a file to facilitate the documentation. The obtained data could be used as a closed loop control system for the door actuator. EZSpeedBox would be installed next to the closure on with a tripod.

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Application Notes:

NVH Applications

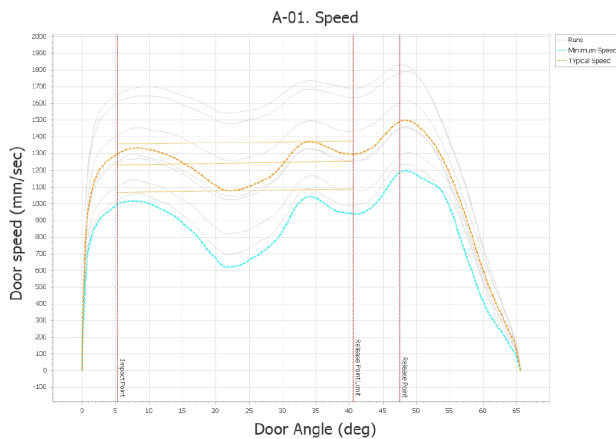
B. Full Speed Curve Recording

B.1 EZEnergy - Wireless

EZEnergy is our next level device in door analysis and can record the full speed profile of the door. EZEnergy combined with Audit software could provide the continuous speed in function of the door angle. This allows to establish a correlation of the position, speed and other data. For NVH Applications, it would be important to record sound characteristics of the door for specific door angles. Speed-angle graphs would provide a comprehensive analysis of the door speed behavior.



Wireless EZEnergy set up on EV car.



Measurement of a speed curve from a car door.

B.2 EZEnergy - Analog

The data from EZEnergy can optionally be made available to the outside application via, for example, Analog Output. This option is however a customized extension, and the format (Voltage Range and Amplification) needs to be defined.

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C. Cabin Pressure

C.1 EZPressure - Cabin Pressure

EZPressure is a fast response pressure sensor focused on characterizing the dynamic pressure change during the extraction of the air trapped in the cabin. The cabin pressure change can be observed during a door closing event. This is a different situation than a flow/leak testing, that recreates a steady state condition. The cabin pressure will generate a damping of the door and by absorbing the energy, changing the vibrations and sounds that can be excited from an impact. By using EZPressure, the seal characteristics can be investigated by measuring cabin pressure changes.

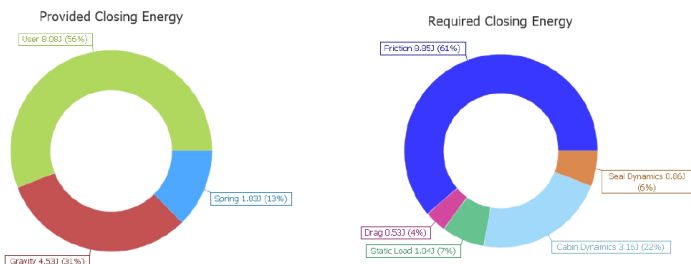


EZPressure placed inside cabin.

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EZSlam Report showing minimum closing energy.

E. Door Setting and Deformation

E.1 EZ3D

EZ3D is a 3D measurement system to quickly and in a very easy way to determine the current flushness or change in flush and gap. This can be a measurement to document the adjustment of the door during sound testing; for example, moving the door up/down or in/out and evaluate the sound signature in function of the different settings. The same measurements can be used to document semi static door deflection due to pressure load. For example, wind tunnel setup to quantify the outbound deflection of the door window frame area. These measurements can be taken from the inside as it consists of taking simple pictures of optical targets attached to door and body and upon the immediate processing in near real time, the 3D displacement is reported.



EZ3D Targets placed on exterior car door.



3D kinematic scan produced from EZMatix.

E.2 EZMatix

EZMatix is an optical tracking system based on optical triangulation to measure dynamic movements of optical makers. There can be as many optical targets as the application requires and the system is available from semi static acquisition all the way to high speed recordings. Typical applications are measurement of deformation of structures under load conditions (torsion, wind load, payload, etc.). Each target will provide a 3D position in time and can be extended with relative motions. In the field of automotive, this is used to capture deflection of chassis, deflection of doors, and relative displacement.

D. Full Door Characteristics

D.1 EZSlam

EZSlam is a complete system that is capable to measure a complete door signature. Prior to sound testing, the door can be mapped for certain physical characteristics or even adjusted to be within a certain range prior to the recordings. This would include parameters such as minimum closing speed, seal compression, cabin pressure, striker alignment, door hinge, etc. The objective documentation of the door being used for sound analysis is essential to establish correlations or understand the influence of components on the sound signature. A dedicated application note "CLA704 EZSlam Door Sound Quality" has been published on this specific topic.