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An Aspect of Noise, Vibration, and Harshness Issues in Electric Vehicles

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Abstract

Electric vehicles (EVs) are gaining ground more recently. New powertrains like electric and hybrid come with new noise, vibration, and harshness (NVH) issues previously unknown. A new approach to acoustic engineering is required to study NVH issues in EVs. The two primary dominant sources in an internal combustion engine (ICE) are engine noise due to combustion, and exhaust noise would not be there for EVs. EVs are less noisy, but several motor or battery cooling noises are encountered during design and validation. NVH is an indispensable part of subsystem integration in the EV powertrain. This article deals with various noise issues generally observed in EVs and their possible treatment to achieve the comfort car, satisfying customer expectations. The NVH-related problems for EVs are categorized into five categories: motor, wind, road, auxiliary, and other noises like integration. A detailed study of each category/problem type and NVH-suppression methods are discussed. The selection of powertrain mount architecture and its impact on load transfer and crash performance are also presented in this article. A balancing approach is required for NVH, durability, and crash requirements.

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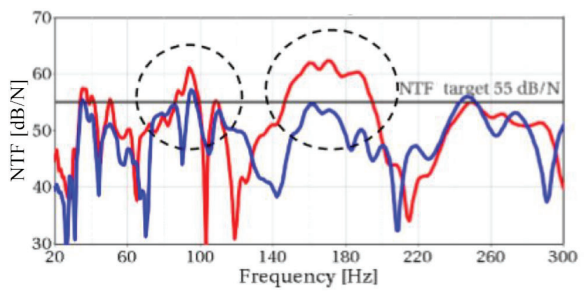
FIGURE 22 Z direction representation NTF for the rear suspension of an EV.



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Conclusions

EVs are so quiet that they constitute a safety hazard for pedestrians and bicyclists in traffic. Even a slight noise can cause discomfort to the occupant. The conventional vehicle powertrain noise masking effect can have both favorable and unfavorable consequences.

This article explains the various noise issues encountered for an EV compared to an ICE vehicle. A detailed study of NVH problems in EVs and their categories are classified based on various noise sources like motor, auxiliary, wind, road, and other sources. The wind and road noise that was not predominant in ICE vehicles become dominant in EVs due to the powertrain masking effect.

Various auxiliary system noises are discussed. The resonance due to fan imbalance poses a threat to steering wheel vibration, which can be addressed through tuning of the fan rpm.

Next, challenges are discussed as an integration-related issue like introducing the AAR joint takes care of the lateral shake and turning noise, which is also discussed in this article.

The selection of the engine mounting system for NVH, crash, and durability are discussed. The balancing of all requirements during integration is discussed. Lastly, integration issues must be adequately managed to address noise due to powertrain integration in EVs.

Overall, the acoustic insulation requirement is very high for EVs, evident from various noise plots.

This article should be beneficial for researchers and vehicle manufacturers interested in developing high-performance EVs at an early stage of development that can provide better attribute balancing.

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Definitions/Abbreviations

AAR - Angular adjusted roller
AI - Articulation index
DOF - Degree of freedom
EBHS - Effective body hole size
EV - Electric vehicle
ICE - Internal combustion engine
LHS - Left-hand side
NTF - Noise transfer function
NVH - Noise, vibration, and harshness
PAT - Performance attribute targets
RHS - Right-hand side
TPA - Transfer path analysis

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