

Quietness Improvement Technologies for a New-Generation Minivan Equipped with a 100% Electric Drive Hybrid System

Namai Yuki¹⁾ Okada Kazuhisa¹⁾ Oana Yuta¹⁾ Kuwata Toshihisa¹⁾ Mori Yukihiro¹⁾

1) Nissan Motor Co., Ltd., Nissan Technical Center, 560-2 Okatsukoku, Atsugi, Kanagawa, 243-0192, Japan

KEY WORDS: vibration, noise, and ride comfort; quietness; e-POWER; sound insulation; Active Noise Control [B3]

As electrified vehicles become widespread, a quiet cabin has become one of the most important sources of customer value. For a premium minivan, quietness not only reduces driver fatigue but also supports conversation, music listening, and relaxation for all occupants. This paper summarizes the quietness improvement technologies developed for a new-generation minivan equipped with the third-generation e-POWER system. The vehicle was developed under the concept of a “Living Room on the Move,” providing a consistently quiet and comfortable cabin environment from vehicle entry to high-speed cruising.

The third-generation e-POWER system combines a power-generation-dedicated 1.5 L turbocharged engine with a highly integrated 5-in-1 electric powertrain unit. For power-generation noise, countermeasures were implemented at the noise source, transfer path, and cabin-response stages. Power plant stiffness was improved through the integrated structure, while the power-generation operating line was optimized to suppress unnecessary engine-speed increases. In addition, e-4ORCE torque distribution control reduced generator-mount loads and enabled the engine mounts to operate in a region with improved vibration isolation. Furthermore, a next-generation Active Noise Control (ANC) system with an expanded control-frequency range was applied to reduce both booming noise and power-generation noise.

Road-noise reduction was achieved through an integrated approach combining chassis, body, and ANC technologies. Anti-vibration subframes were adopted for both front and rear suspensions, and low-rate struts and upper insulators were developed to reduce vibration input transmitted from the road surface to the vehicle body. In addition, low-frequency drumming noise was reduced by avoiding modal coupling between body structural modes and closure-panel modes. Residual low-frequency cabin noise was further reduced by the next-generation ANC system.

Airborne-noise reduction focused on establishing an ideal double-wall sound-insulation structure from the early design stage. Sound-insulation areas were first defined around the dash, floor, and wheel-house structures, and component layouts within these areas were carefully designed to prevent mounting holes and gaps from becoming sound-transmission paths. Around the dash structure, separate sound-insulation components were assembled to maximize metal coverage while minimizing openings around the steering shaft, wiring harnesses, and head-up display. In the floor area, seat-rail packaging and carpet layout were developed simultaneously to maximize floor-metal coverage. For the sliding-door area, trim geometry, seal layout, and harness routing were optimized to acoustically separate the pocket space from the cabin and establish a continuous double-wall structure. In addition, high-damping acoustic glass was applied to reduce wind noise and side-transmitted noise while maintaining high sound-insulation performance around the entire vehicle.

Figure 1 shows the interior noise levels under representative urban and high-speed driving conditions. The new minivan achieved a substantial reduction in interior noise compared with the current model and provided the quiet cabin environment required for the “Living Room on the Move” concept. These results were achieved through the integrated application of powertrain, chassis, body, ANC, and sound-insulation technologies.

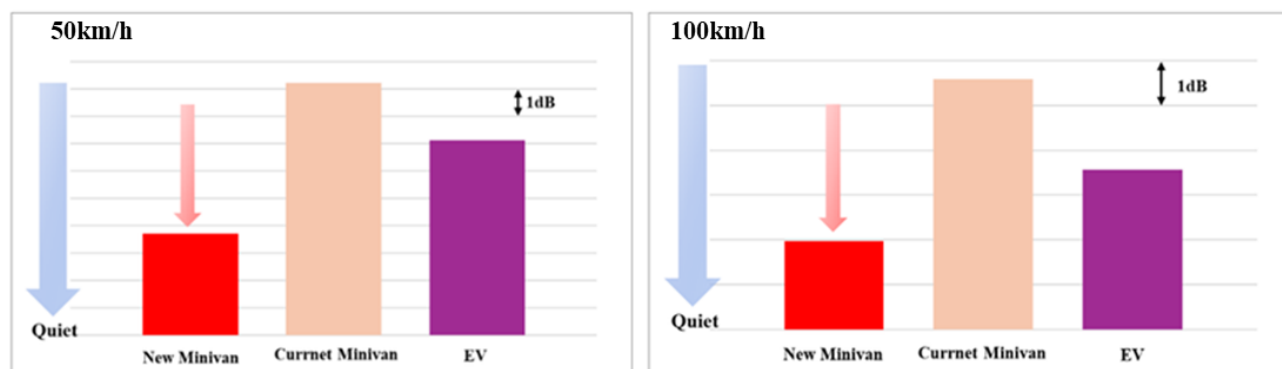


Fig.1 Interior noise (50 km/h and 100 km/h)