INDUSTRIAL PRODUCTS

ANTI-VIBRATION MOUNTINGS FOR ELECTRIC VEHICLES

THE ROLE OF ANTI-VIBRATION MOUNTINGS IN ELECTRIC VEHICLES

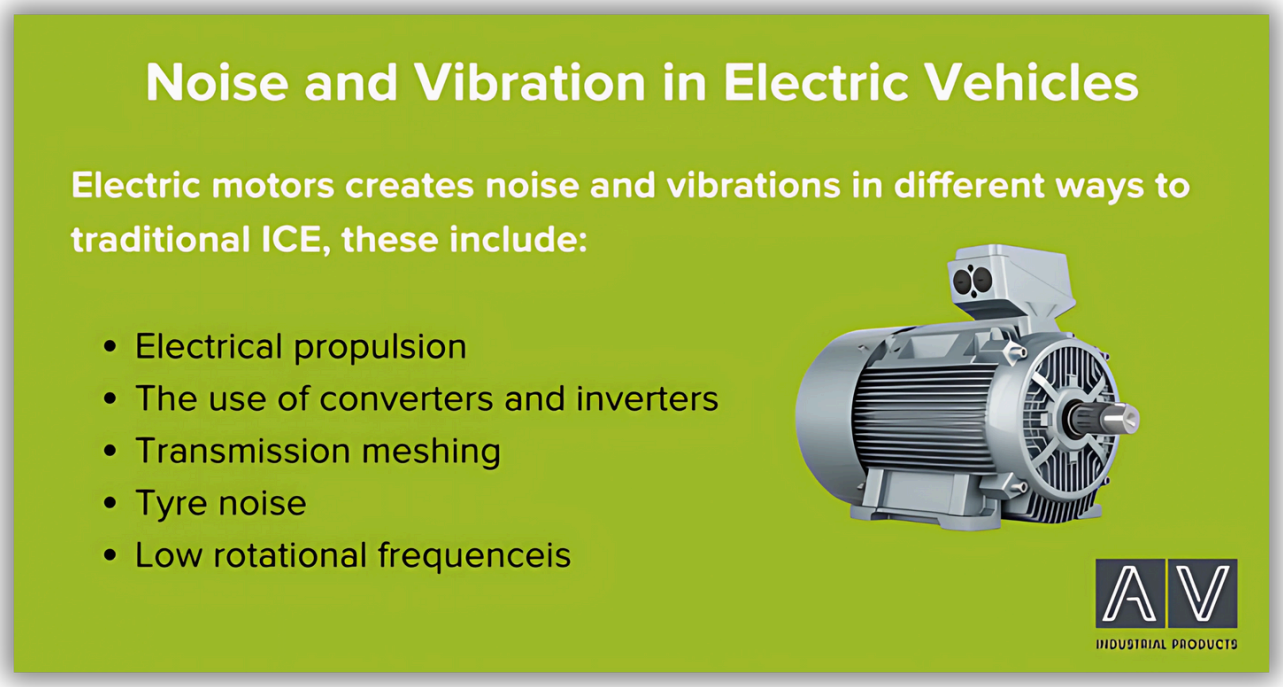
As the automotive and off-highway industries undergo electrification, the transition from internal combustion engines (ICE) to electric motors (EM) brings new challenges in noise, vibration, and harshness (NVH) control. Traditional vibration isolation strategies must be adapted to account for differences in vibration characteristics, torque delivery, and overall system dynamics.

Where Are Anti-Vibration Mountings Used in EVs?

Anti-vibration mountings play a crucial role in several key areas of electric vehicles (EVs), including:

- **Powertrain Mounts** – Supporting electric motors and inverters while managing torque and vibration.
- **Suspension Mounts** – Absorbing road-induced vibrations in heavier EVs.
- **Battery Isolation Systems** – Reducing dynamic loading and extending battery life.
- **Battery Cell Mounts** – Protecting individual battery cells from excessive vibration and thermal expansion effects.
- **Cabin Mounts** – Enhancing operator comfort by minimizing NVH.
- **Ancillary Equipment Mounts** – Isolating components like cooling systems, inverters, and power electronics from unwanted vibrations.

Key Technical Considerations for EV Anti-Vibration Mounts



1 Vibration Spectrum of Electric Motors vs. Internal Combustion Engines

Unlike ICEs, which generate low-frequency vibrations (typically between 20-200 Hz) due to cyclic combustion events, electric motors produce higher-frequency vibrations, often exceeding 500 Hz, caused by electromagnetic forces, inverter switching, and gear meshing. This requires mounts designed to dampen high-frequency resonances more effectively.

Parameter	ICE Vibration Spectrum	EV Vibration Spectrum
Frequency Range	20-200 Hz	500 Hz+
Dominant Sources	Combustion pulses, rotating components	Motor switching, gear meshing, inverter harmonics
Torque Fluctuation	Periodic with ignition cycles	Instantaneous, high torque at low speed

2 Torque Considerations in EVs

Electric motors deliver instant torque, which means the mounts must handle sudden, high-force loads. This results in greater bi-axial load transfer (side-to-side and front-to-back movement), requiring mounts with:

- ✓ Higher shear and compressive strength to withstand rapid torque surges.
- ✓ Optimized damping characteristics to prevent excessive movement.
- ✓ Torsional flexibility to accommodate load shifts.

3 Material Considerations for EV Mounts

Traditionally, natural rubber has been the preferred material for anti-vibration mounts due to its excellent damping properties and durability. Whilst this remains the case for EV applications, additional materials can offer other benefits:

- ✓ **Natural Rubber (NR):** Excellent resilience and isolation properties.
- ✓ **Silicone Rubber (SI):** Withstands high temperatures and offers better electrical insulation.
- ✓ **EPDM (EPDM):** Superior resistance to weathering and ozone exposure.
- ✓ **Chloroprene Rubber (CR):** Improved resistance to oils and chemicals found in EV cooling systems.

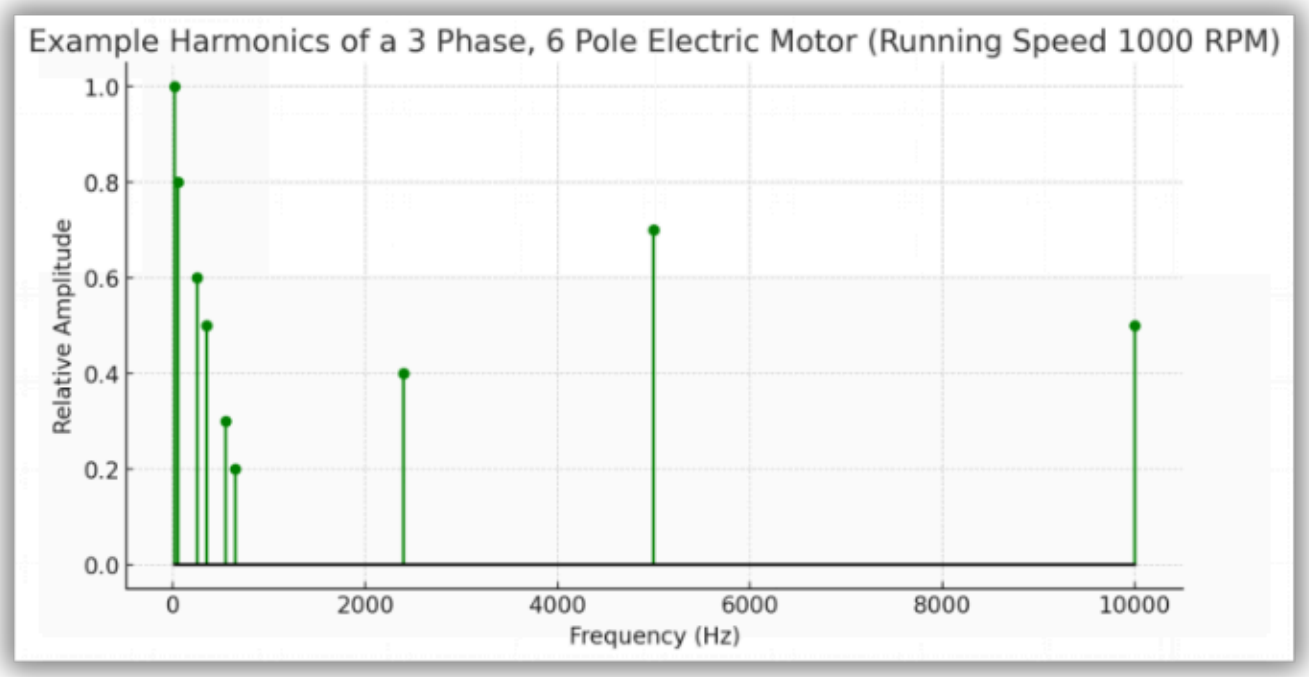
Typical Vibration Frequencies in EVs

Electric motors, inverters, and power electronics introduce new vibration profiles. Below is a comparison of typical vibration frequencies in EV components:

Component	Typical Frequency Range	Vibration Characteristics
Electric Motor	500 Hz – 10 kHz	High-frequency resonance, electromagnetic noise
Inverter	1 kHz – 20 kHz	Switching harmonics, structural excitation
Gearbox	50 Hz – 5 kHz	Gear meshing noise, transmission resonance
Battery Pack	10 Hz – 200 Hz	Road-induced vibrations, structural fatigue
Battery Cells	10 Hz – 500 Hz	Thermal expansion effects, vibration fatigue

Three-phase electric motors are often the preferred choice for construction and industrial vehicles due to their high efficiency, durability, and superior torque characteristics. Unlike single-phase motors, three-phase motors provide continuous and balanced power delivery, reducing vibrations and ensuring smoother operation. Their high starting torque makes them ideal for heavy-duty applications, such as electric excavators, loaders, and dump trucks, where significant force is required to move heavy loads.

The graph illustrates and example of the key harmonic frequencies generated by a 3-phase, 6-pole electric motor running at 1000 RPM. The mechanical rotation frequency is 16.67 Hz, while the fundamental electrical frequency is 50 Hz, as determined by the motor's pole count. Electrical harmonics appear at multiples of the fundamental frequency, with the 5th (250 Hz), 7th (350 Hz), 11th (550 Hz), and 13th (650 Hz) harmonics being prominent.



Addressing NVH Challenges in EVs with Anti-Vibration Mountings

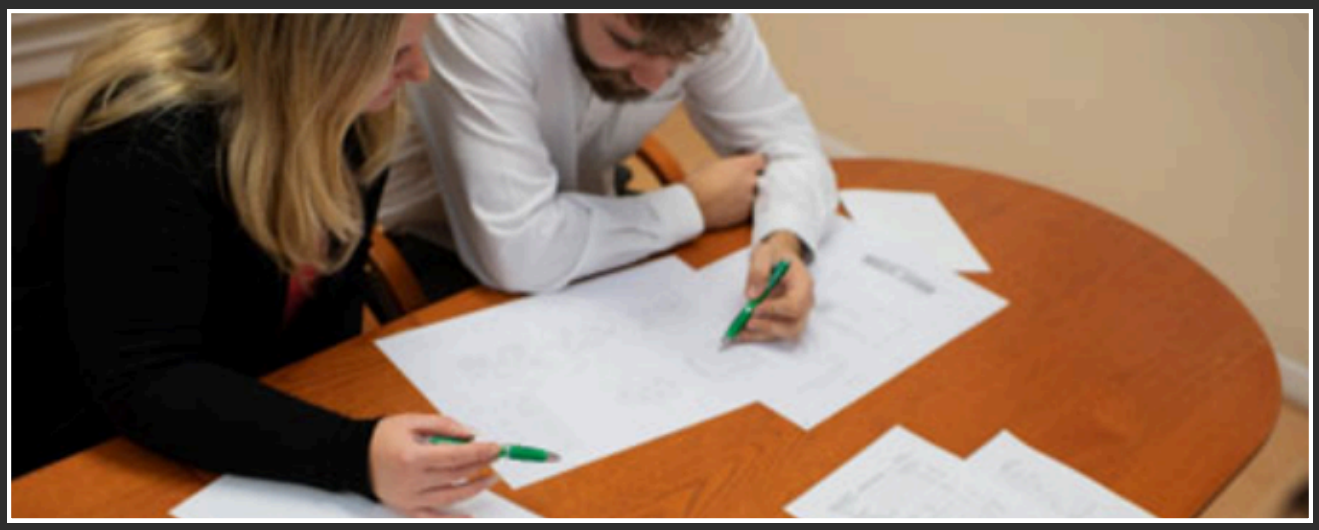
To minimize noise and vibration, AV Industrial Products Ltd provides industry-specific solutions that address these challenges:

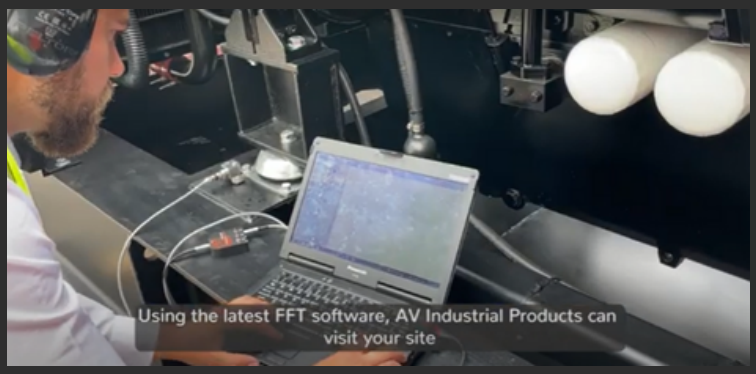
- ✓ **Custom Engineered Mounts:** Optimized for EV torque response and high-frequency damping.
- ✓ **Battery Isolation Systems:** Protecting battery packs and individual cells from road vibrations and extending lifespan.
- ✓ **Cabin Mounting Solutions:** Ensuring operator comfort with precision-engineered NVH control.
- ✓ **Durable Materials:** Using rubber compounds optimized for EV conditions, including temperature extremes and high torque loads.

Partnering with AV Industrial Products for EV Solutions

With decades of experience in vibration isolation for off-highway and automotive industries, AV Industrial Products Ltd understands the unique demands of electric vehicle applications. We offer tailored solutions designed to:

- ✓ Minimize noise, vibration, and harshness (NVH).
- ✓ Extend component lifespan and reliability.
- ✓ Enhance operator safety and comfort.
- ✓ Improve vehicle durability and reduce downtime.
- ✓ Support environmental and regulatory compliance.





As the industry moves towards electrification, selecting the right anti-vibration solutions will be critical in ensuring performance, efficiency, and longevity in electric vehicle fleets. Contact AV Industrial Products Ltd today to discuss how we can support your EV vibration control needs.

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