

Acoustics design

A sophisticated sound system that can produce an array of signals offers customized engine sounds for electric and hybrid vehicle acoustic refinement



The IPG5 actuator can be mounted directly onto the vehicle chassis

▶▶ A silent vehicle can represent a safety hazard. However, newly developed devices can now add sound to electric and hybrid vehicles to enhance the driving experience and conform to new safety standards.

Vehicle sound is a personal preference: every individual has a different idea of what sounds good and what is considered noise. An electric or hybrid vehicle, however, provides a completely different experience from the traditional ICE vehicle as there is virtually no acoustic feedback in electric mode to indicate speed, acceleration and deceleration. Most EV drivers appreciate the low noise level of their vehicles and quickly get used to the total absence of noise, especially from the engine.

Kendrion's HAB128 sound actuator for external sound (front and back view)

Yet while drivers and passengers welcome the quiet comfort of an EV, the unexpected quietness of this new generation of vehicles can represent serious problems for pedestrians and others outside the vehicle. Since there is no sound from the engine, it is difficult for pedestrians to realize when a car is approaching from behind. That's why an acoustic vehicle alerting system (AVAS) has been legislated by several governments as a feature of future EV product lines.

A recent study of EV drivers conducted by a large vehicle manufacturer revealed mixed opinions on AVAS technology. While the vast majority of drivers consider it a very useful feature, many of them also like having the ability to switch it off in some situations as there are

times when the sound can be unpleasant or even annoying.

This has led to the conclusion that while AVAS is definitely a vital technology, especially for EVs, the presence of such synthetically generated sound is not fully appreciated by all drivers. Another conclusion is that most, if not all, EV owners consider the low interior noise level to be a truly pleasant experience and do not really miss the typical acoustic feedback of driver vehicle interaction that drivers have become accustomed to.

EV manufacturers have developed different approaches to this. While some aim to simulate a certain acoustic response of the vehicle in line with changing driving situations, others have instead preferred not to employ any noise actuators at all to

influence the interior acoustics of their electric vehicles.

Another trend in the field of electric vehicle acoustic design is an increasing focus on controlled external sound emissions by an AVAS that is designed in such a way that it has certain effects on the interior perception of sound as well.

Automotive suppliers such as Kendrion are extremely familiar with the challenges of EV sound development. The company's experts can adapt to a wide range of manufacturing philosophies while keeping an eye on the reactions of the first adopters in a market still in the early stages of development.

"When used in conventional automobiles, sound systems provide an acoustic signature to improve the overall driving experience. This is a significant feature to increase driver and passenger comfort as well as develop and maintain brand identity. As an added benefit the actuators also mask a variety of noise sources that become more evident due to the absence of any dominant engine noise," says Michael Richter, head of electro-acoustics development at Kendrion passenger cars.

Kendrion has developed a two-pronged product strategy to address the sound requirements for electric vehicles conforming to the upcoming standards.

The IPG5 is a sound actuator designed to induce structure borne sound that is emitted to both the exterior and the interior of the vehicle. The highly compact unit has a diameter of only 55mm and can be mounted directly onto the chassis at any suitable location.

The HAB128 is an embedded actuator designed primarily to produce exterior sound. It is equipped with a seismic transducer featuring a carbon sandwich membrane that provides a sound pressure of up to 85dB. The actuator generates bending waves that result in exactly the type of sound expected from an AVAS.

Both these models of sound actuator produce a warm and natural sound and are extremely compact. They offer an extended low frequency range, wide sound dispersion and a radiation pattern of up to 180°. Another benefit of the actuators is that the sound source cannot be localized acoustically. It seems to be omnipresent and appears to be part of the natural acoustic surroundings of the car, whether it is cruising through the city or traveling along a highway at high speed.

The Kendrion EV sound system solution consists of two hardware components: a sound actuator and an electronic control unit with

CANbus interface and eight flashable sound profiles. All components offer IP6K/9K rating and are resistant against extreme temperatures as well as frequent exposure to dust and water.

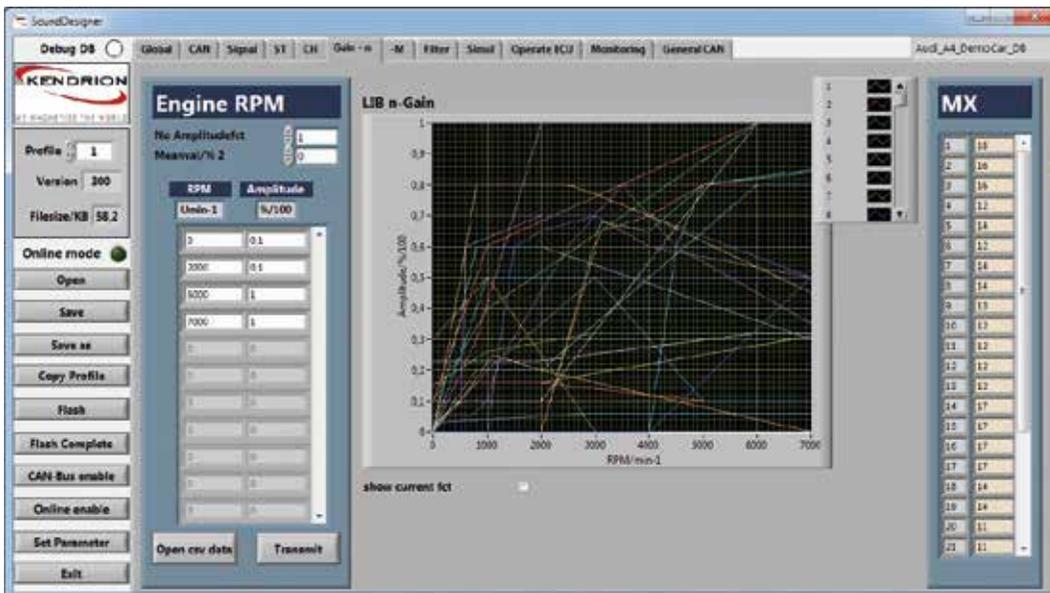
The intended interior and/or exterior sound can be developed with a special sound design software package. This system features a graphical user interface and creates soundtracks consisting of any combination of sampled and synthetically generated sound components. The sound system supports live editing, meaning that the sound pattern will change depending on parameters such as engine speed, torque, acceleration and deceleration. The required vehicle information, such as engine RPM and pedal positions, is derived via the CANbus from the vehicle's onboard controller and enables the generation of a situation-related ambient sound output that can be perceived both inside and outside of the vehicle.

There is one issue, however, that automotive sound designers are still unsure of. The majority of drivers have their idea of what a high-quality sports car or an elegant luxury limousine should sound like. But what kind of sound is expected from an electric vehicle? What will be considered a pleasant sound by the car buyers of tomorrow? Will they consider sound a necessary evil or welcome it as a contribution to an enhanced driving experience?

"It is hard to predict actual market expectations at the moment," says Richter, "but good automotive sound will always be sound that is only perceived subconsciously.

"Kendrion can deliver for the exact requirements for each vehicle – sound that will add to the overall driving experience without driver and passengers actually realizing why this is the case. That's why we work hard to make sound systems that are as inconspicuous and effective as possible."

Information on engine RPM can be used in the generation of situation-related ambient vehicle sound



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