



Product/Technology Communications

Josef Schloßmacher
Tel: +49 (0)841 89-33869
e-mail: josef.schlossmacher@audi.de
www.audi-mediaservices.com

Product/Technology Communications

Tanja Lehner
Tel: +49 (0)841 89-34105
e-mail: tanja.lehner@audi.de
www.audi-mediaservices.com

Acoustic innovation: e-sound by Audi

- **The brand is developing new sound signatures for its future e-tron models**
- **A control unit generates sound based on signals from the car**
- **A loudspeaker broadcasts the sound signature**

Ingolstadt, April 5, 2012 – Audi’s future e-tron models will cover long distances powered by practically silent electric motors. To ensure that pedestrians in urban settings will hear them, the brand has developed a synthetic solution: Audi e-sound.

Rudolf Halbmeir’s workstation is not exactly typical of an Audi engineer. There is a digital piano on his desk, two studio-quality loudspeakers next to his computer monitor, and a pile of music magazines off to the side. “A car’s sound,” says Halbmeir, an acoustics engineer, “is similar to music.”

Sound is an especially exciting aspect of a vehicle. Although it can be described in physical terms, there is no substitute for experiencing it firsthand. A car’s sound is emotional, not intellectual. Although we consciously register a car’s sounds only occasionally while on the road, they are always there – playing a crucial role in the driving experience. Sounds send signals. Low-range frequencies suggest power and composure, while mid-range frequencies emit sportiness and agility.

All Audi models produce sound signatures which are not only well-rounded and harmonious, but also broadcast performance, premium quality and respectability. “Good sound design is a complex endeavor,” explains Dr. Ralf Kunkel, Head of Acoustics at Audi. “We have gathered a lot of expertise over the years. We have also learned how to amplify pleasant frequencies and to suppress unpleasant noises.”



In a series-production Audi, a combustion engine currently supplies the music. Conversely, the motor in an electric-powered e-tron is not an option, as it is too quiet and its high frequencies are not exactly melodious. Audi's e-tron models will therefore feature a synthetic sound signature. Rudolf Halbmeir teamed up with his colleagues Axel Brombach and Dr. Lars Hinrichsen to create it.

They used computers to do most of the work. Using software to mix and listen to tones, assess, and then re-mix: Halbmeir is truly enthusiastic about the creative process. After all, in his spare time, he writes songs and composes music in his own recording studio – where he himself plays a lot of instruments. “I create one-of-a-kind emotional sound structures,” says Halbmeir. “There aren't many differences between music and a vehicle's sound. I trust my instincts and have to try out new ideas to determine where they will take me.”

Which ideas, exactly? “Some science-fiction films provided inspiration suitable for certain frequency ranges,” responds Halbmeir. “But there was nothing in the real world which offered quite the right sound. When you compose music or sounds, you have to be true to your convictions. The moment you cut corners, you essentially end up with elevator music.” Dr. Ralf Kunkel adds: “Because we here at Audi are all automotive experts, we have a great advantage over sound specialists elsewhere. We know our vehicles inside and out, not to mention how they operate and behave.”

The e-sound by Audi may be artificial, but it is authentic. In fact, the e-tron itself generates its sound by the millisecond. Dr. Lars Hinrichsen, the expert for hardware and software, explains: “Data relating to the electric motor's rotational speed, vehicle speed, loads, and other parameters is continuously supplied by the vehicle to the control unit. It then uses this data to generate sound.”

The e-sound is played via a sturdy loudspeaker attached to the car's undercarriage. Axel Brombach, the specialist in this field, shares details: “We designed it to handle as much as 40 watts, but during normal operation it ranges between five and eight watts. That's loud enough for nearby pedestrians and cyclists to hear the e-tron.” A fraction of the sound signature enters the vehicle's interior via airborne and structure-borne sound waves. “We could utilize sound paths and mechanical actuators for more sound in the interior,” explains Dr. Kunkel. “After all, a vehicle body is basically a large soundboard.”



But we believe strongly that our e-tron models call for an atmosphere of calm, which best conveys the unique experience of electric driving.”

Key measurements: the acoustic test bed

A change in scenery: the acoustic test bed on the building’s ground floor is a large room, spanning some 350 m² with a seven-meter ceiling. Dense rows of wedges full of glass wool, each a meter in length, project from the walls. These wedges absorb a majority of any sound energy; things sound almost like they do outdoors. In the middle of the room is a dynamometer test bed, between two long rows of microphones atop tripods. The dynamometer serves primarily to measure noise as if the vehicle were driving by, with tires on the roller and the microphones gathering acoustic data.

Halbmeir and his colleagues used the acoustic test bed to achieve many key advancements for the R8 e-tron prototype, which features e-sound technology. All the while, they had to remain aware of regulatory developments. Dating back to early 2011, guidelines are being crafted in the United States regarding the volume of alerts emitted by electric vehicles. “We’ll probably have to ensure audible alerts only up to 30 km/h; above that speed, the tires generate enough noise,” says Dr. Kunkel. “But that isn’t quite satisfactory – we’ll surely increase the upper limit for alerts.”

“The test bed was a key development tool for us,” says Axel Brombach. “It did not, however, allow us to genuinely evaluate the e-sound. We were missing everyday conditions such as motion, wind, and other vehicles. So we then drove on actual roads. Listening, seeing, feeling: they all go together.”

Out of the building and to the street. A red Audi R8 e-tron pulls up around the corner, purring gently. But when Rudolf Halbmeir taps the gas pedal, the purr turns into a cultivated growl. Though not unlike an elegant V8, it is especially pure and nuanced, and is shrouded in bright and innovative overtones. The Audi R8 e-tron certainly sounds like a sports car, but also one-of-a-kind and very futuristic. Halbmeir stops the car and inquires with a grin: “Great, isn’t it?”



And e-sound for this electric-powered high-performance sports car is just the beginning. Each and every Audi e-tron model will have a sound signature all its own – similar, yes, but each one unique. Because an Audi's sound is not just any music: it is *Vorsprung durch Technik* to one's ears.

- End -

The Audi Group delivered 1,302,659 cars of the Audi brand to customers in 2011. In 2011 the Company posted revenue of €44.1 billion and an operating profit of €5.3 billion. Audi produces vehicles in Ingolstadt and Neckarsulm (Germany), Győr (Hungary), Changchun (China) and Brussels (Belgium). The Audi Q7 is built in Bratislava (Slovakia). In July 2010, CKD production of the Audi Q5 was added to the existing Audi A4 and A6 manufacturing operations in Aurangabad (India). At the Brussels plant, production of the Audi A1 has been running since May 2010, while production of the new A1 Sportback began in 2012. The Audi Q3 has been built in Martorell (Spain) since June 2011. The Company is active in more than 100 markets worldwide. AUDI AG's wholly owned subsidiaries include AUDI HUNGARIA MOTOR Kft., Automobili Lamborghini S.p.A. in Sant'Agata Bolognese (Italy), AUDI BRUSSELS S.A./N.V. in Brussels (Belgium) and quattro GmbH in Neckarsulm. Audi currently employs around 64,000 people worldwide, including around 48,000 in Germany. Between 2012 and 2016 the brand with the four rings is planning to invest a total of €13 billion – mainly in new products and the extension of production capacities – in order to sustain the Company's technological lead embodied in its "Vorsprung durch Technik" slogan. Audi is currently expanding its site in Győr (Hungary) and will start production in Foshan (China) in late 2013.

Audi has long been fulfilling its social responsibility on many levels – with the aim of making the future worth living for generations to come. The basis for Audi's lasting success is therefore formed by environmental protection, the conservation of resources, international competitiveness and a forward-looking human resources policy. One example of AUDI AG's commitment to environmental issues is the Audi Environmental Foundation. Under the heading of "Audi balanced mobility," the Company is directing its activities toward a major goal – comprehensive CO₂-neutral mobility.