



The Audi sound system: tailor-made acoustics for every Audi model

- **Sound tuning and sound design shape sound experience**
- **Audi programs its own development software**
- **Challenge: car interiors offer difficult conditions for listening enjoyment**

Ingolstadt, May 12, 2021. What effect do sounds have on people? And how does Audi translate its customers' subjective auditory sensations into the car as objectively as possible? With the help of sophisticated sound development, Audi is reaching its acoustic objectives.

Be it a violin concerto, an operatic aria, a radio drama, hip-hop, or a warning signal: Audi's sound designers have set the highest goal for themselves: reproducing sound in the way that soloists, bands, speakers, or orchestras recorded it. The typical Audi sound should be natural and give passengers the feeling of being completely surrounded by the music or speech. The positive effect of mid-level frequencies on the human psyche serves as a benchmark. At the same time, low frequencies cannot function separately on the floor or high frequencies on the roof. On the contrary, a holistic frequency response is critical for a natural listening experience.

Wolfram Jähn, an audio developer at Audi since 1999, and his colleagues in sound design want to do justice to an extremely wide range of listening habits. To that end, the experts have a firm principle: whenever someone gets into an Audi with their favorite music, the sound has to have an immediate emotional impact. That person has to want to hear that piece of music in the Audi. The sound has to be clear, precise, and dynamic. "To give you an illustration, in the past, customers with the system integrated into an Audi have heard that the percussion sticks are made of wood," says Jähn. "With the current advanced system, musicians can even hear what kind of wood it is."

Difficult, more difficult, interior acoustic space

When buying a car, many customers pay particular attention to the audio system. That is because the car is specifically where people listen to music enthusiastically and frequently. According to a study by the International Federation of the Phonographic Industry, 70 percent of music lovers like to listen to music best while driving. Additionally, music in the car relieves stress, as researchers at São Paulo State University (UNESP) in Brazil recently learned. For their



experiment, they sent women between the ages of 18 and 23 on 20 minute trips on various days through a major city during rush hour – once with music and once without. Without music, the test subjects’ heart rates were significantly higher.

Where sound is concerned, customers wish for a sound that at least reaches the level of the music system in their living room. That is why AUDI built its own reference listening room with a high-end system. However, reaching that level of sound is a major challenge for automakers. That is because the interior of a car is considered an extremely difficult acoustic space. It is full of reflecting and absorbing surfaces – and different distances between speakers and listeners’ ears. For that reason, speakers have to be positioned and controlled within the car so that they function in a balanced way.

Digital signal processing for balanced sound

Audi’s experts use sound tuning to tailor an acoustic custom fit for each model. Digital signal processing with a signal processor is one of the most important procedures for doing that. Before checking the hardware that is built into the car, the speakers are first examined using acoustic measurement techniques. Audio developers fix their basic filter by looking at frequency response as well as build up and decay. Additionally, the speakers’ signals can be controlled with individual time offset so that they reach the listener at the same time. For that reason, each speaker in the car has its own output stage. Once the built-in systems have been corrected and adjusted, then comes the Audi audio developers’ supreme discipline: sound design.

The sound committee assesses sound design

At this stage of sound development, the developers adjust the frequency response so that the typical but still subjective Audi sound emerges. Audi has been working with partners like Bang & Olufsen for years for that purpose. “Many colleagues in the company and among our partners have roots in the musical field. Without that, we couldn’t calibrate a sound system at all,” says Jähn. To achieve the greatest possible objectivity and quality, Audi audio developers are presenting the completed design to a sound committee that will ideally approve of the respective sound system for the series by a majority.



Sound source as a particular challenge

Another factor in sound quality is the source of the sound. High-end multichannel recordings could be played back on DVD players, followed a few years ago by compressed sources like MP3s, which were not the optimal solution for what the hardware built into an Audi can do. Meanwhile, streaming services like Spotify, Amazon Music, Tidal, Qobuz, or Deezer now offer high-definition – which is to say losslessly compressed – sources for high-end car sound systems. Lossless CD quality with 16 bit and 44.1 kHz (1411 kbps) and even recordings with 24 bit and 192 kHz (4608 kbps) are available in ultra HD quality. Sources like these make more intelligent use of hardware possible and pave the way for immersive audio, which means plunging the listener into a space-consuming sound experience. Additionally, with the upcoming models on the new Premium Platform Electric (PPE), a high quality mobile communications receiving unit is to be installed directly into the car to make the quality-reducing signal transmission redundant when listeners are streaming music from a smartphone via Bluetooth.

soundCube: in-house development for efficiency and quality

Audi has been using the software soundCUBE, which it developed itself, since the summer of 2019. Consequently, the audio developers control 100 percent of the technology that they use in an Audi. Thanks to soundCUBE, the experts can choose the best algorithms available on the market and integrate them themselves. With soundCUBE's graphic user interface DSP Studio (Digital Signal Processing), the developers control the individual filters for overall signal processing for the different sources, like telephone, navigational announcements, or hi-fi audio. "With our tool, sound engineers from Bang & Olufsen, Sonos, and Fraunhofer IIS are sitting in the car and doing the fine tuning," says Wolfram Jähn. The resulting data set is then adjusted in production. The outcome is an optimal sound that can be individually calibrated to the equipment and the engine. "In the course of doing this, a holistic sound experience is an objective and a benchmark – from hi-fi to switch clicks, from phone conversations to warning signals, from podcasts to symphony concerts," says Wolfram Jähn.

Since the electric compact SUV the Q4 e-tron Audi has also been collaborating with Sonos in the audio field. Customers who know Sonos from home appreciate their energetic sound, which fits particularly well with Audi's compact models.

Despite all the technology, Audi's sound developers agree: there is no replacement for a trained ear at any given stage of development. "Only through analytical listening by experienced experts



can an unadulterated, emotional, and natural sound that emotionally grips the listener transfer into the car,” says Wolfram Jähn.

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