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Automotive Audio System Industry Report, 2023

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Technology development: personalized sound field technology iteration accelerates

From automotive radio to “host + amplifier + speaker + AVAS” mode, automotive audio system has passed through several technological iterations, and tends to be personalized and intelligent. In current stage it has been integrated as part of intelligent cockpit. In specific modes, it can be combined with seat, display, ambient light, intelligent voice assistant and other functions to meet owners' needs for personalized experience of sound effect.

Technically mainstream vehicle models highlight application of zone tuning and immersive sound field technologies, in addition to use of more speakers:

- 1. In tuning technology, sound effect algorithm, frequency shift algorithm, sound wave simulation algorithm, in-car active noise reduction, multi-zone sound field replay, speaker array broadband sound field control and other acoustic signal processing algorithms are critical.
- 2. In sound field technology, Dolby Atmos and sky surround sound are widely used, and enabled through headrest audio and canopy speaker.



Source: IM Motors

Installation of Sound Zoning in Top 20 New Energy Models (by Sales Volume) Launched on Market in Recent Year, Jan.-Jul. 2023

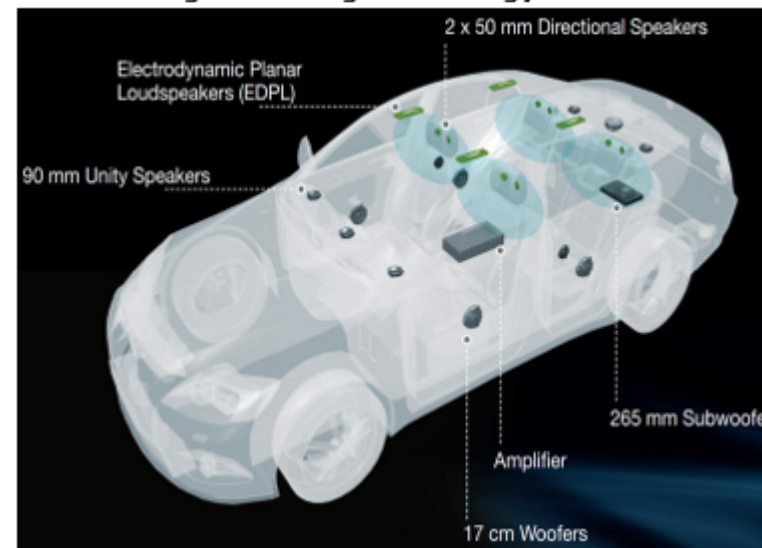
Model	Sound Zoning Available or Not	Number of Sound Zones	KTV
Model Y 2022 RWD	×		✓
Yuan PLUS 2022 430KM	✓	2	×
Model 3 2022 RWD	×		✓
Yuan PLUS 2022 510KM	✓	2	×
Li L9 2022	✓	6	✓
Changan Lumin 2022	×		×
Model Y 2022 Modified RWD	×		✓
Deepal SL03 2022	✓	4	×
Model Y 2022 AWD	×		✓
Li L7 2023	✓	4	✓
Li L8 2023	✓	6	✓
Wuling Bingo 2023	×		×
Song Pro New Energy 2022 DM-i	✓	2	×
Song Pro New Energy 2022 DM-i Pro	✓	2	×
AION Y 2022	×		×
AION S 2023	×		×
Qin PLUS 2023 DM-i	✓	2	✓
NIO ET5 2022	✓	4	✓
Dolphin 2023	✓	2	✓
Model 3 2022 AWD	×		✓

Source: ResearchInChina

Zone tuning and KTV mode boasted far higher installation rates in models launched on market in recent year:

In addition, during upgrading the audio system solution, different scenario modes also boost optional audio components business. For example, in Li Auto's L family, the ambient light can be linked with the audio system in KTV mode, and Li Auto Mall also launches matched microphones, including four-mic / two-mic version, priced at RMB 799/459, respectively.

Intelligent Zoning Technology of Harman



Source: Harman

Audio System of Li L7 Can Be Linked with Ambient Light

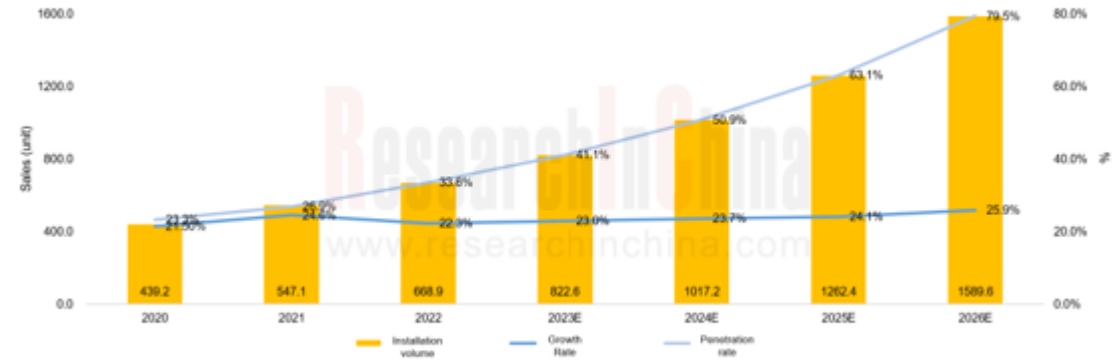


Source: Li Auto

Market status: new energy models with more than 8 speakers per vehicle accounted for more than 45% of the total sales

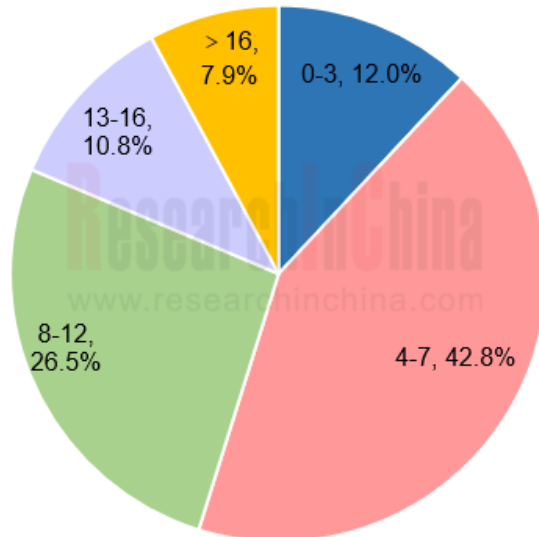
Starting from 2020, the sales of passenger cars each with more than 8 speakers have been on the rise. As of December 2022, the sales of passenger cars each with more than 8 speakers have reached 6,689,000 units, with a penetration rate of 33.6%; the growth rate is projected to range at around 23% in 2023; it is conceivable that in 2026 the penetration rate will reach up to 79.5%, and the sales will achieve 15.896 million units, with CAGR of 24.16%.

Sales of Passenger Cars Each with More Than 8 Speakers, 2020-2026E



Source: ResearchInChina

Sales Structure of New Energy Models by Number of Speakers (Standard Configuration), Jan.-Jul. 2023
(Models with 8+ Speakers Accounted for Over 45%)



Source: ResearchInChina

In 2023, in terms of numbers of speakers (standard configuration) per vehicle, the top ten models by sales volume pack 6, 4, 8, 2, 12, 10, 9, 14, 7, and 16 speakers, respectively. The 21-speaker and 23-speaker solutions were launched in 2022, and the sales of matched models surged by over 150%, of which the typical 21-speaker models were Li Auto's L family and the typical 23-speaker models were NIO ET5/7 and ES7/8; the 14-speaker models also grew over 140%, mainly driven by the sales of Model Y and Denza D9.

The use of more speakers and the further iteration of audio system technology have favored higher audio system value per car. As of September 2023, the content-per-car value of audio system has averaged over RMB1,500; with additional cost of RMB500-1,000, the cost of high-end models has increased by RMB2,000-2,500.

Content-per-car Value of Audio System for Mid-/Low-/High-end Models

Audio System Component	Number of Speakers Installed in Mid/Low-end Models	Number of Speakers (Standard Configuration) Installed in <u>High-end</u> Models
Speaker	4-6	8-12
Host	1	1
Amplifier	1	1
Woofer	-	1
AVAS	1	1
Content-per-car Value (RMB)	1,300-1,500	1,850-2,000

Source: ResearchInChina

OEMs: emerging carmakers lead the way in vehicle audio solution iteration

BYD Yangwang U8 Is Equipped with 22 Dynaudio Evidence Series Speakers



Source: BYD

From 2020 to H1 2023, among models of conventional OEMs like SAIC and FAW, passenger cars with over 8 speakers took a low share, compared with a high proportion in emerging carmakers. Wherein, Tesla Model 3/Y is equipped with more than 8 speakers; over half of the models of Great Wall and BMW Brilliance carry more than 8 speakers.

Conventional OEMs differ from emerging carmakers in audio system solution design and planning:

- 1. Conventional OEMs (FAW-Volkswagen, FAW Toyota, BMW Brilliance, etc.) prefer the outsourcing model where suppliers are responsible for audio design, equipment, and tuning services. Thereof, mid- and low-end models use speakers from white-label suppliers, while high-end models cooperate with audio brands;
- 2. Emerging carmakers (Tesla, NIO, Xpeng, Li Auto, etc.) pay more attention to cost reduction. They adopt the model of “independent design of audio system solutions, outsourcing of equipment/tuning, and provision of tuning software OTA services”, and self-develop some tuning algorithms (e.g. sound effect algorithm for Li L9).

Audio R&D Modes of Some Emerging Automakers

OEM	Model	Audio R&D Mode
Xpeng	G6	Self-develop solutions, and outsource the production to GSEC
Li Auto	L series	Self-development of solutions, equipment provided by Sonavox, tuned by Dirac (partially self-development)
NIO	ET5/7, ES6/7/8	Self-development of solutions, equipment provided by Sonavox, tuned by Dirac
Tesla	Model 3/Y	Self-develop key components including microphones

Source: ResearchInChina

In R&D of audio system technologies, most conventional OEMs tend to develop acoustic quality adjustment and sound field technologies (e.g. headrest audio technology):

Audio Technology R&D of Conventional OEMs

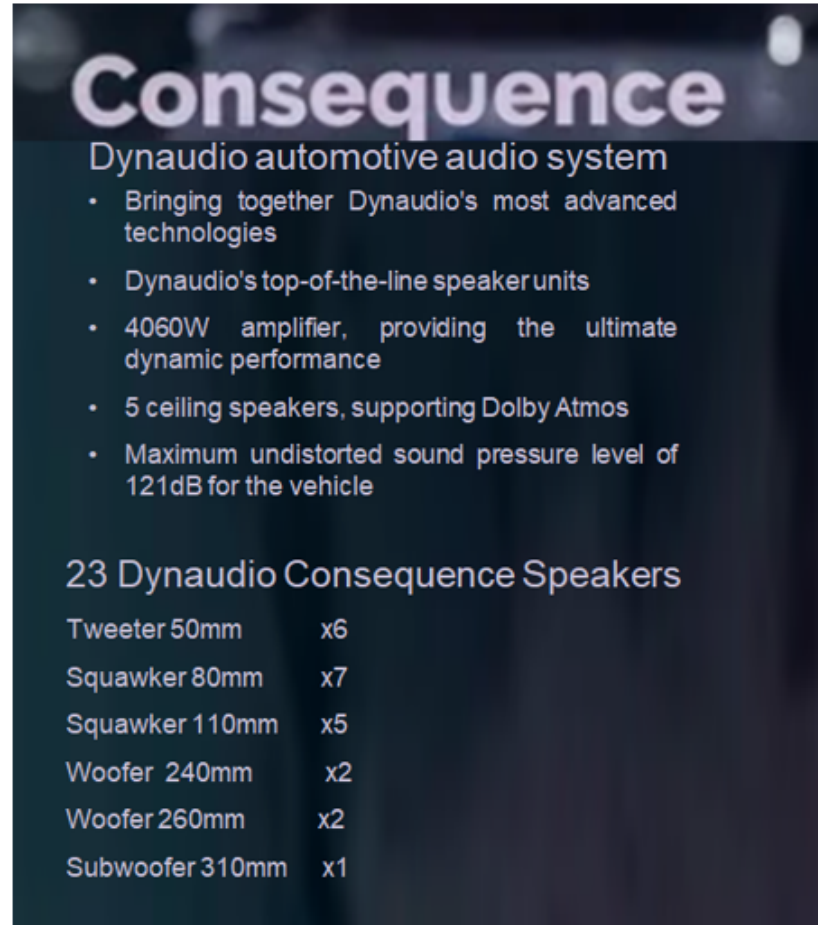
OEM	Launch Time	Technology
Geely	Dec. 2022	Musical seats with headrest audio portfolio
FAW	May 2023	Automatic adjustment of acoustic quality in sound field
	Dec. 2022	The subwoofer equalization control in the car is enabled via the woofer control signal, which can equalize the sound pressure level at different locations in the car.
Great Wall Motor	Jan. 2022	Based on a 3D cockpit model, build virtual musical instruments and control the audio
Changan Auto	May 2023	Automatically adjust the audio system
	Nov. 2021	Musical headrest

Source: ResearchInChina

Suppliers: white-label manufacturers boast a surging share, and tuning suppliers become superior

From January to July 2023, the top 10 audio suppliers by installations took a combined market share of lower than 60%, of which the top three, Goertek Dynaudio, Harman and Martin Logan boasted installations of 1,077,000 units, 698,000 units, and 327,000 units, respectively. Among them, Goertek Dynaudio supported models of Xpeng and BYD; Harman's multiple brands such as Harman Kardon, Infinity, JBL and Revel covered a wide range of models of BMW, Great Wall Motor, Lincoln and others. After a surge during 2021-2022, the growth of audio brands slowed down; white-label manufacturers such as Sonavox grew by over 45% in H1 2023, much higher than audio brands.

Dynaudio Consequence Automotive Audio System Displayed at the Auto Shanghai 2023 Packs 23 Speakers



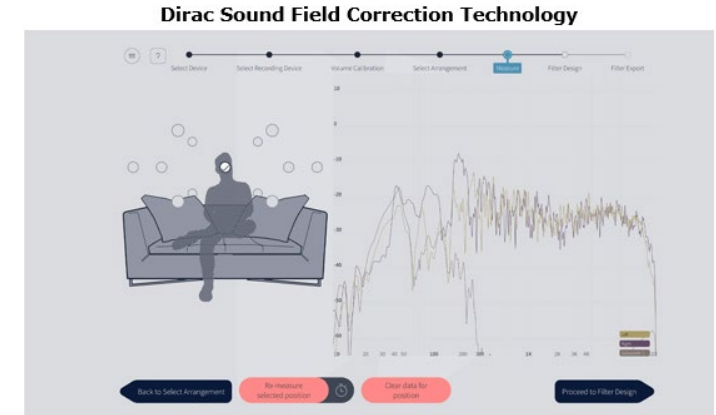
Consequence
Dynaudio automotive audio system

- Bringing together Dynaudio's most advanced technologies
- Dynaudio's top-of-the-line speaker units
- 4060W amplifier, providing the ultimate dynamic performance
- 5 ceiling speakers, supporting Dolby Atmos
- Maximum undistorted sound pressure level of 121dB for the vehicle

23 Dynaudio Consequence Speakers

Tweeter 50mm	x6
Squawker 80mm	x7
Squawker 110mm	x5
Woofer 240mm	x2
Woofer 260mm	x2
Subwoofer 310mm	x1

Source: Dynaudio



Source: Dirac

As concerns ecosystem, emerging carmakers put more focus on software tuning technology. Relying on DSP chips and sensor technology, they change the existing brand audio system solutions via software tuning system and OTA services, and then turn to the “software tuning + white-label OEM” mode. The overall audio solution is that white-label/brand manufacturers provide audio hardware, and emerging carmakers configure tuning systems according to hardware and build algorithms based on models of tuning engineers, meeting users’ personalized tuning requirements. In this context, Dirac and other tuning suppliers remain superior, with tuning algorithms slashing vehicle cost.

In the recent two years, Xpeng Motor and BYD among others have launched “musical cockpit” and “musical coupe” in their new energy models. They are backed by comprehensive solutions developed by audio brands such as Dynaudio and Harman using their own acoustic technologies. In May 2023, Harman planned to use its brand audio to further create an overall musical cockpit product line, including a new-generation musical cockpit which combines Harman’s technologies in intelligent vehicle connection and brand audio, and improves user experience in all aspects from vision and hearing to telematics.

Functions of Harman Music Cockpit

Cockpit Function	Technology	Characteristics
Vision	Neo QLED and OLED	Provides pure black, dazzlingly bright displays and HD images with low power consumption
Hearing	Quantum Logic Immersion, sound zoning, HALOsonic suite, etc.	3D surround, sound zoning

Source: Harman; ResearchInChina

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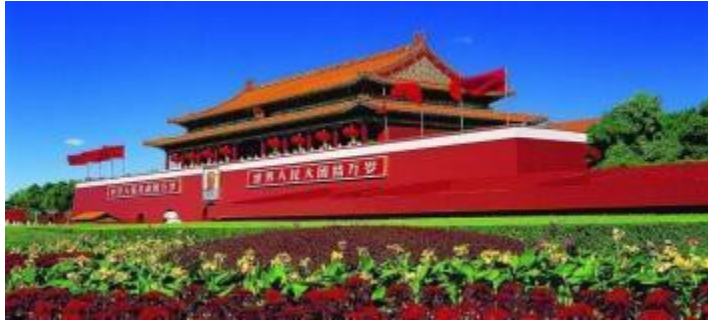
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