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Automotive Ultrasonic Radar and OEM Parking Roadmap Development Research Report, 2023

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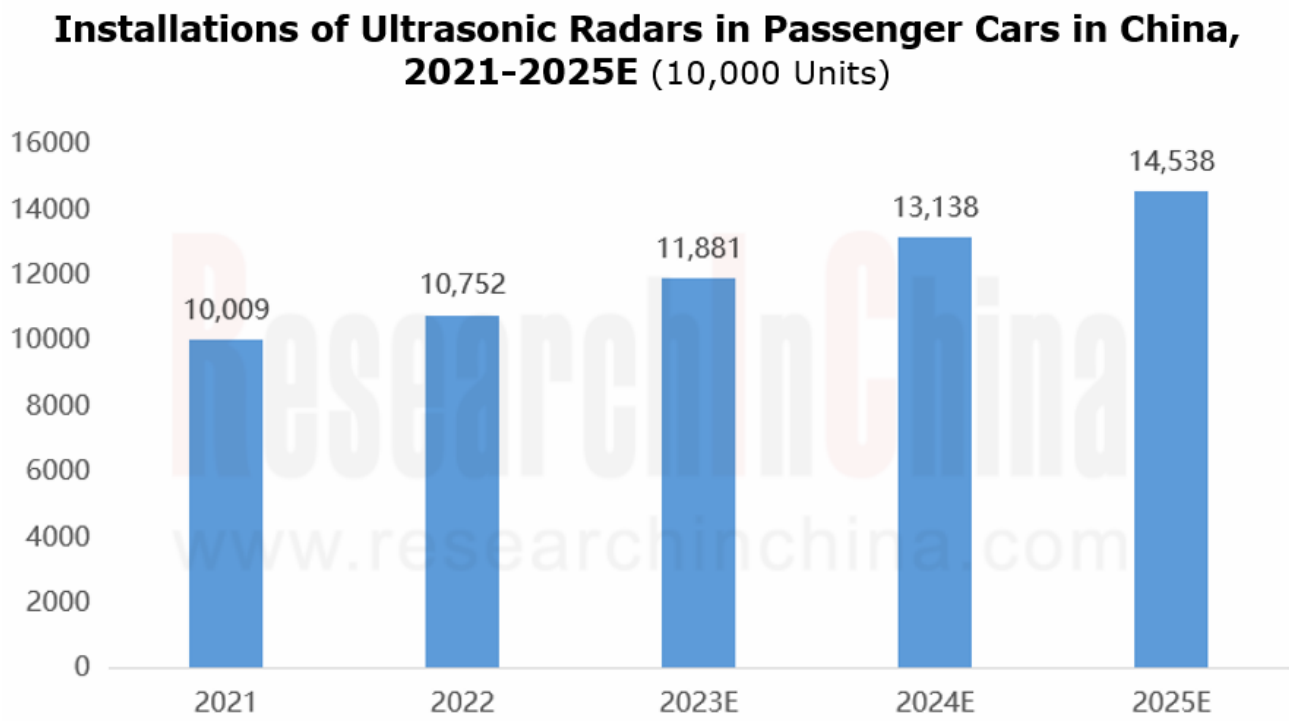
Automotive Ultrasonic Radar Research: as a single vehicle is expected to carry 7 units in 2025, ultrasonic radars will evolve to the second generation.

As a single vehicle is expected to pack 7 units in 2025, ultrasonic radars will take the fast lane.

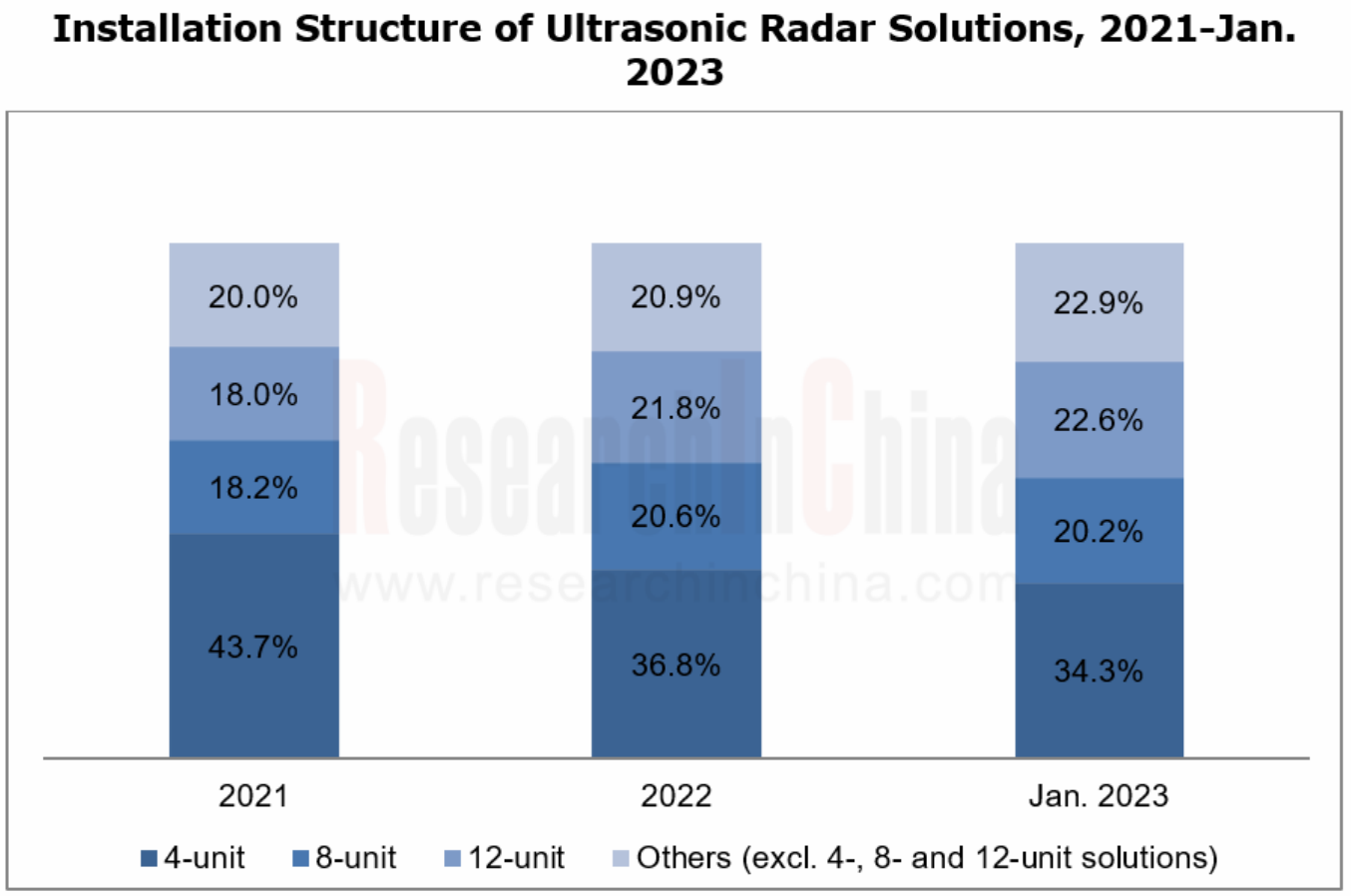
According to the statistics of ResearchInChina, the ultrasonic radars installed in new passenger cars in China swelled by 7.4% year on year from 100.09 million units in 2021 to 107.525 million units in 2022. It is expected that the installation will exceed 140 million units by 2025. From 2021 to January 2023, there were an increasing number of ultrasonic radars installed in a single vehicle, up from 4.9 units to 5.6 units. Thanks to factors such as large-scale application of driving and parking integration, and the integration of cockpit and parking, it is expected that ultrasonic radars per vehicle will rise to 7 units in 2025, and the ultrasonic radar market will enjoy a boom.



Source: ResearchInChina

Installation Structure of Ultrasonic Radar Solutions, 2021-Jan. 2023

In terms of installed solutions, in 2022, 36.8%, 20.6% and 21.8% of new passenger cars in China carried 4-, 8- and 12-ultrasonic radar solutions, respectively; AVP used 12-ultrasonic radar solutions. In 2022, 28,804 vehicles with AVP were sold, rocketing by 589% on the previous year.



Source: ResearchInChina

Ultrasonic radars evolve to the second generation - AK2 ultrasonic radar

Amid the growth in installations and demand, ultrasonic radar technology is also advancing, and has iterated to AK2 ultrasonic radar. Compared with conventional ultrasonic radars, AK2 ultrasonic radar offers the following benefits:

Longer detection range (>5m), smaller blind spot (<10cm).

More echoes: DSI3 communication mode is adopted, providing the highest rate of signal propagation, up to 444kbit/s; at most 230 echoes can be supported in a sensor detection cycle.
Anti-interference
ASIL-B
Waveform coding
Multi-mode switching (for example, Longhorn AK2 supports three transmission modes: fixed frequency mode, rising delta frequency mode and falling delta frequency mode)
Diagnosis function (for example, Bosch's sixth-generation ultrasonic radar can detect hardware deafness).

Comparison between AK2 Ultrasonic Radar and Existing Ultrasonic Radars

	Existing Ultrasonic Radars	AK2 Ultrasonic Radar
Longest detection range	450cm	>500cm
Blind spot	<20-25cm	0~10cm
Ranging accuracy	≤5cm	≤1cm
Ranging resolution	1cm	≤1cm
Functional safety	QM	ASIL B
Sensor deafness detection	Unable to detect	Special diagnosis function
Coverage detection (ice, snow, etc.)	Low detection probability	Special diagnosis function
Sonic encryption	Fixed frequency	Frequency modulation
Connection mode	P2P	P2P (DSI3 Bus)
Sensor structure	No standard	Standard size
Operating temperature	-40 ~ 80℃	-40 ~ 95℃

Source: EnjoyMove Technology

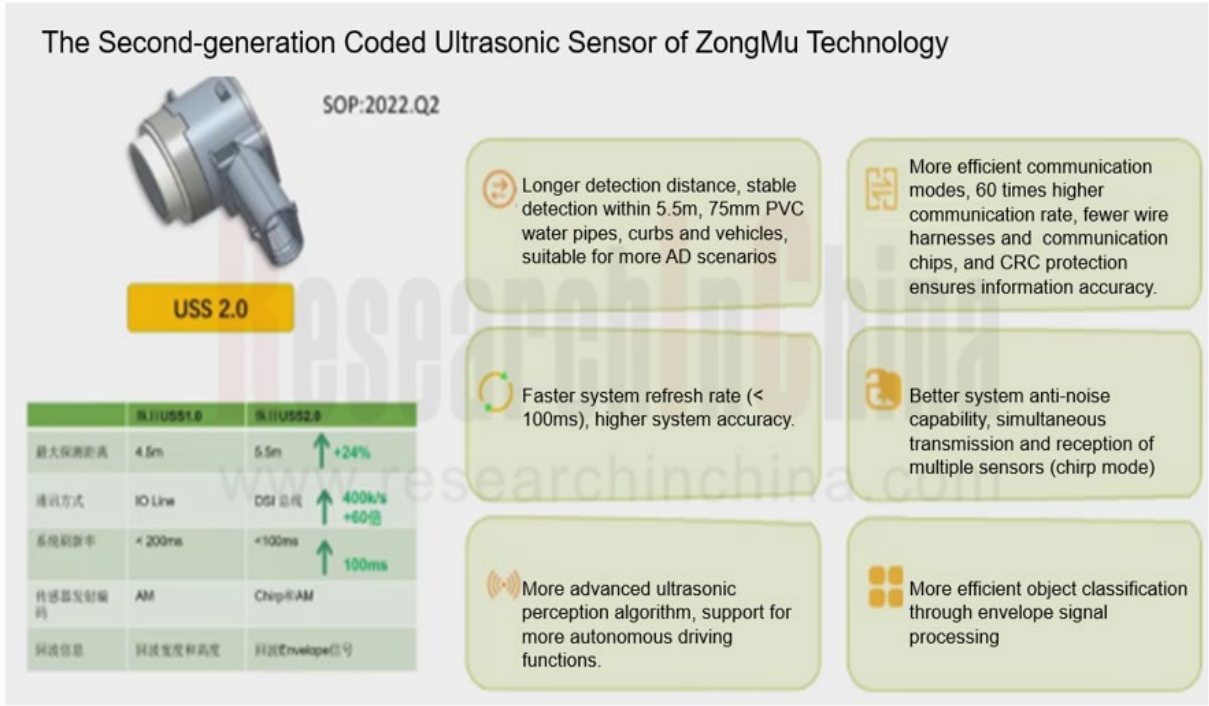
AK2 layout

Regarding the AK2 layout, foreign manufacturers started earlier than Chinese companies. In 2016, Bosch successfully developed the sixth-generation ultrasonic radar, which combines digital signals and signal codes together and enables sensors to achieve multiple receptions and multiple transmissions through a linear frequency. Continental's full-stack solution based on its CUS3 ultrasonic sensor (with longest detection range of 5.5m, and self-diagnosis capability) is planned to be produced in quantities in 2024. The next-generation products of Murata Manufacturing can be used together with the ElmosE 524.17 driver chip to support frequency conversion (coding), with the blind spot only covering 15cm, and the longest detection range of 5.5m.

In China, both Audiowell Electronics and ZongMu Technology mass-produced AK2 radar in 2022; Coligen and Suzhou UDAS plan mass production in 2023; the rest companies are developing or have successfully developed AK2 radar.

Among them, the second-generation coded ultrasonic sensor of ZongMu Technology meets the German AK2 sensor appearance design standard. Through the Chirp (linear frequency modulation) coded transmission mode, the self-developed point cloud perception algorithm and probe enable the anti-noise capability of the system, with the refresh cycle in the encoding mode less than 100ms. The signal envelope helps to improve the detection of low obstacles such as ground locks and limiters. The product supports such functions as parking space monitoring, emergency braking, automatic space detection, target clustering and generation, and adaptive compensation of sensor performance parameters. The AK2 sensor was mass-produced in the second quarter of 2022, supporting customers like JAC Group, Voyah, Changan Automobile (Changan APA 7.0) and Seres.

AK2 Ultrasonic Sensor of ZongMu Technology



Source: ZongMu Technology

Comparison of AK2 Coded Ultrasonic Radar Layout between Chinese Manufacturers

Comparison of AK2 Coded Ultrasonic Radar Layout between Chinese Manufacturers

Manufacturer	SOP	Key Features	Functions	Supported Models
Audiowell Electronics	2022	Synchronous processing of multiple echo eigenvalues, multi-mode switching. 8K FM bandwidth, simultaneous transmission and reception of different acoustic signals for avoiding frequency interference.	● Longest detection range: 7 m; ranging accuracy: ±2 cm; resolution: 1cm. Minimum blind spot: 15 cm. ● Enable UPA and APA functions via single sensor. ● Realize parking functions such as APA and automated parking; HPP will be possible in the future.	SAIC-GM, Chery, Lotus, etc.
Coligen	2023	Mainly for autonomous driving	Detection range: 0.15-6m	-
Longhorn	2022 (launched)	The software architecture and interface comply with Autosar standards. Three transmission modes: fixed frequency mode, rising delta frequency mode and falling delta frequency mode. Multiple echo events, multiple transmissions and multiple receptions.	● Longest detection range: 7m. Detection accuracy: 1cm. Blind spot:<10cm ● Used for automated parking, automatic braking, accelerator misstep prevention and other functions; ● Diagnosis function: detect the failure of the ultrasonic sensor when it is covered with ice, mud and snow.	-
ZongMu Technology	Q2 2022	Enable anti-noise capability of the system in the Chirp (linear frequency modulation) coded transmission mode. Compliant with German AK2 sensor appearance design standard; high universal interchangeability. The self-developed point cloud perception algorithm and probe allow for long-distance detection and wide FOV. The refresh cycle in encoding mode is less than 100ms.	● 360° perception within 5.5m around the vehicle body. ● Parking space detection and autonomous emergency braking (AEB). ● Freespace detection, target clustering and generation, obstacle detection and object classification. ● Adaptive compensation of sensor performance parameters and other functions.	JAC Group, Voyah, Changan Automobile and Seres
Hefei Softec Auto Electronic	July 2021 (launched)	Auto-encoding, auto-thresholding, near-field data collection. High robustness and good diagnosis capability; automatic measurement of aftershock time and frequency; integration of temperature sensor and DSI3 communication interface.	Blind spot detection, automatic pull-in/out, and LAEB/PDC.	SAIC
ForVision	Mass-produced	-	Alarm function.	-
Thundersoft	Developed successfully	-	Detection range: 7m.	-
Shanghai Baolong	Developed successfully	Long-range blind spot detection	Longest detection range: 10m	-
UDAS	October 2023	Anti-interference at the same frequency	● Longest detection range: 8m. ● Adapt to AVP and other autonomous driving systems above L3	In Dec. 2022, designated by a new energy vehicle brand in China for its brand-new platform model.

Source: ResearchInChina

Will ultrasonic sensors be replaced by radars in the future?

In recent years, ultrasonic sensors have faced challenged from radars. For example, in 2022, O-Film Tech introduced a solution of applying radars to low-speed autonomous driving for the purpose of space perception, and enabled the parking function using its self-developed 77Ghz radar. In 2022, TransMicrowave unveiled a short-range point cloud imaging radar, which can output 4D (X, Y, Z, V) point cloud information and enables automated parking in the 4D point cloud AVP mode, with the localization accuracy of 2cm. Tesla even announced to globally remove ultrasonic radars from Model X and Model Y since 2023. Does this mean that ultrasonic radars will be replaced or no longer needed?

On the one hand, ultrasonic radars have a big cost advantage in short-distance ranging, and gain ever more competitive edges. Besides the iteration of AK2 ultrasonic sensor, ultrasonic radars tend to be miniaturized and hidden. One example is AW101, a MEMS ultrasonic sensor developed by Audiowell Electronics in November 2022, mainly used for rear occupant alert (ROA), sound controlled by gesture, VR&AR and so forth. The MEMS ultrasonic sensor is a new kind of sensor that integrates piezoelectric thin films (as functional thin films) with silicon-based MEMS for miniaturization, integration, and hidden installation. The micron-level functional films and millimeter-level devices of the sensor facilitate further integration, compounding and arraying, and make it easy to design SiP and SoC devices and built circuits in.

On the other hand, ultrasonic sensors are finding application in more scenarios from parking to in-cabin monitoring. For example, Coligen is expanding the application of ultrasonic sensors in wading warning, height limit warning, low-speed F/RAEB, load warning, reverse drive assist, and AVP based on multi-sensor fusion; Suzhou UDAS is also exploring the use of ultrasonic sensors in low-speed AEB, and high-speed lane change and blind spot detection.

Besides, multi-sensor fusion represents the development trend of autonomous driving technology. At present, vehicle intelligence is undergoing "cockpit and parking integration" and "driving and parking integration", and will see "cockpit and driving integration" soon. For them, ultrasonic radars should be integrated with different sensors to achieve different levels of functions. Examples include automated parking, enabled by “ultrasonic radars + surround view cameras” in the “cockpit and parking integrated” architecture; navigate on pilot and homezone parking pilot, enabled by “ultrasonic radars + multi-view cameras + radars” in the “driving and parking integrated" architecture; urban/end-to-end navigate on pilot, homezone parking pilot (across floors) and L2 AVP, enabled by “ultrasonic radars + multi-view cameras + radars” in the “cockpit and driving integrated" architecture.

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