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Passenger Car Radar Industry, 2022-2023

Oct. 2023

- In 2023, over 20 million radars were installed, a year-on-year jump of 35%;

Driven by multiple factors such as driving-parking integration, NOA and L3, 5R solutions will become the mainstream configuration in the market in 2026.

- Influenced by the rising sales of China's local suppliers, intelligent involution and other factors, localization is a megatrend.

- 4D radars have landed on vehicles on a small scale and are expected to be mass-produced and installed on a large scale during 2025-2026.

- At present, 4D radars mainly involve cascade solutions; single-chip solutions will become the focus of the future layout and be implemented in 5-8 years.

* Analysis on BOM of Jingwei Hirain's MRR510 front radar.

1. **In 2023, over 20 million radars were installed, a year-on-year jump of 35%; it is estimated that more than 5 million 4D radars will be installed in 2026**

According to ResearchInChina, 20.021 million radars will be installed in new passenger cars in China in 2023, up 21.6% year on year; in 2026, the number will hit 39.618 million.

From January to June 2023, the overall installations of 4D radars in new passenger cars in China exceeded 114,000 units, accounting for 1.3% of the total radar installations. In terms of the replacement order, 4D radars will first replace front radars, that is, priority will be given to meeting the driving needs in intelligent driving, and second replace corner radars to better meet high-level safety function requirements. It is expected that the installations of 4D radars will reach 5.594 million units in 2026, making up 14.1% of the total radar installations.

Source: ResearchInChina

Main factors driving up radar installations: Consumer side

The main factors driving up radar installations include:

Consumer side: OEMs focus on deploying NOA functions, of which 5R becomes standard

NOA, a hotspot in the layout of major OEMs, includes highway NOA, urban NOA and commute NOA, among which 5R NOA solutions prevail in the market.

Highway NOA (L2.5): At the end of 2020, some Chinese automakers began to apply NOA to highway scenarios, and highway NOA thus became a layout highlight. In 2022, highway NOA intensively boarded vehicles.

Urban NOA (L2.9): In the second half of 2022, Xpeng, AITO and other OEMs took a lead on planning urban scenarios, extending NOA from highways to urban areas. In 2023, most leaders engaged in intelligent driving released their urban NOA plans, so 2023 marked the first year of urban NOA.

Commute NOA: it is the combination of urban NOA + route memory, and the selling point is to make it convenient to commute. It is likely to become another new arena following urban NOA. At present, companies that have launched such a solution include Li Auto and Xpeng.

NOA Solutions of Some OEMs

Company	Intelligent Driving System/ Solution	Time	Models supported	Configuration
NIO	NOP (highway NOA)	2021	NT1.0 platform: EC6 2020/2022; ES6 2019/2020/2022; ES8 2020/2022	5R7V12U
	NOP + enhanced pilot (urban NOA)	Jul. 2023 (Beijing)	NT2.0 platform : EC7/ES6/ES8 2023 ; ES7/ET5 2022 ; ET7 2023	5R11V1L
Li Auto	Highway NOA	Feb. 2023	Air/Proof L series	1R10V
	Urban NOA	Late 2023	Max of L series	1R11V1L
	Commute NOA	Tested in Jun. 2023	L9 MAX	1R11V1L
Xpeng	Urban NGP (urban NOA)	Mar. 2023	G9, P7i Max	5R12V12U2L
	AI valeting (commute NOA)	Jul. 2023	G6. It is planned to be introduced to all XNGP owners in Q4 2023.	5R12V12U2L
Great Wall Motor	Urban NOH (urban NOA)	Apr. 2023	WEY Mocha DHT-PHEV, WEY Blue Mountain	5R4V12U
SAIC MAXUS	UTOPILOT (urban NOA)	Jun. 2023	MIFA9	5R7V12U
IM	IM AD (urban NOA)	Apr. 2023	IM L7, IM LS7, IM LS6	5R11V12U

Source: ResearchInChina

Main factors driving up radar installations: Supply side

For the driving-parking integrated solutions launched by many international and Chinese Tier 1 suppliers such as Aptiv, ZF, Freetech and iMotion, 5R has become the standard configuration of most mid-to-high-end solutions. According to the statistics of ResearchInChina, from January to May 2023, 490,000 sets of driving-parking integrated solutions were installed in production models, a like-on-like spurt of 138%; the installation rate hit 6.7%, up about 3.8 percentage points from the prior-year period. By 2025, the installations will reach 6.19 million sets, and the installation rate will climb to 30%.

As L3-related laws and regulations mature, the implementation of L3 has been put on the agenda, and will become another driving force for 5R solutions. For L3 solutions launched by Tier 1 suppliers, such as Bosch, Aptiv, Hong Jing Drive and MAXIEYE, 5R has also been a standard configuration.

The implementation of NOA and driving-parking integration as well as future L3 solutions will directly boost the installations of 5R solutions. According to the data from ResearchInChina, it is estimated that the proportion of 5R solutions will be 8.15% in 2023, 5.49 percentage points higher than that in 2021; the proportion of 5R solutions will reach up to 39.6% in 2026.

Driving-parking Integrated Solutions and L3 Solutions of Some Tier 1 Suppliers

Company	Solution	Time / Landing	Configuration
Aptiv	Gen 6 ADAS Platform: Core, Plus, Pro	Iterated in 2021 Mass production expected in H2 2024	Core1: 1V; Core2: 1R1V Plus 1: 3R1V + ASDM ; Plus 2: 5R1V + ASDM ; Plus 3: 5R1V + ASDM Pro1: **5R1V1L** + OSPAS Pro2: **5R8V1L** + OSPAS
	Driving-parking integrated solution	Exhibited at Auto Shanghai 2023	Core: **5R6V** + OSPAS Pro: **5R11V** + OSPAS
	Gen 6 ADAS Platform Pro-Premium Pro-Luxury	Released in 2021	**5R1V1L** + OSPAS **5R8V1L** + OSPAS
Bosch	Bosch Driving Assist	Mass production expected in 2023	**5R6V12U** DASy 1.0 mid
ZF	coPILOT	Mass produced in mid-2022	**5R6V** Nvidia, ProAI
	coDRIVE	Product page updated in 2021	**5R4V, etc.** Mobileye
Freetech	Driving-parking integrated solution	Released in 2021 5R6V available in Geely Boyue L and Lynk & Co 09	ADC20+**6V5R** ADC25+**10V5R** ADC30+**12V5R3L**
SenseTime	SenseAuto Pilot	Medium configuration solutions have landed in GAC AION LX Plus and Neta S. High configuration solutions are planned to be mass-produced in 2023	Low configuration solution: 1R6V12U Medium configuration solution: 5R11V12U High configuration solution: 5R11V12U3L
Hong Jing Drive	Hyperpilot 3.0	Expected to be released as early as 2024	**5R11V**
MAXIEYE	MAXIPILOT 3.0	Announced to be under development in 2023	**5R11V**

Source: ResearchInChina

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Radar chips have passed through four development phases: radio frequency front end + processor; single SOC + digital analog; small-scale separation of SoC to the large-scale; a single chip can meet the needs of OEMs for high-level intelligent driving, a phase when the functional applications and scenarios of intelligent driving have basically been solidified, and the demand from OEMs has also stabilized.

4D radar technology routes can be roughly divided into multi-chip cascade, single-chip integration, virtual aperture imaging, and metamaterials. Currently, the 4D radars that have been or will be installed in passenger cars are mainly multi-chip cascade, especially two-chip and four-chip cascade. Mature single-chip solutions will have cost performance/cost advantages, and are expected to become the focus of the future layout and be implemented in 5-8 years.

Models such as BMW IX, Li L7, and Rising Auto R7 have been confirmed to be equipped with 4D radars. Among them, Rising Auto R7 adopts ZF's FRGen21 front radar, 4-chip cascade 12T16R from TI and Xilinx, and Hella's 4D corner radar; Li L7 Pro uses WHST's STA77-6 front radar, and 2-chip cascade 6T8R from TI.

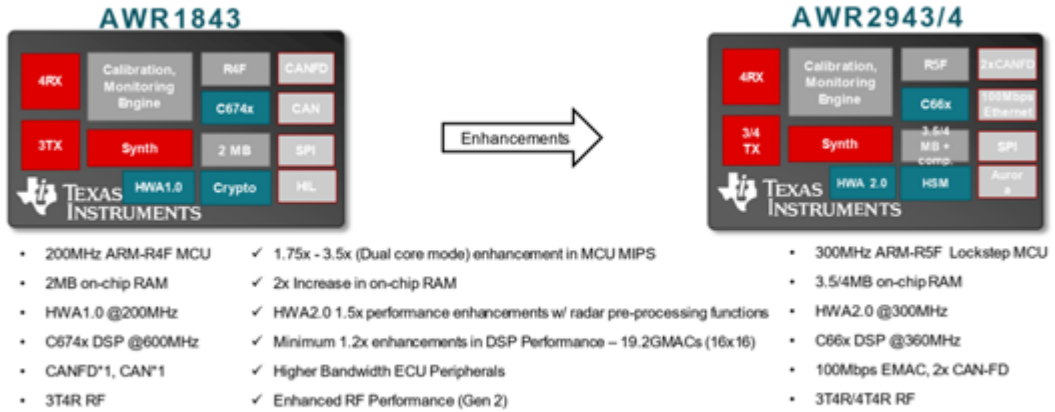
ZF FRGen21 (Left) and WHST STA77-6 (Right)

Source: Public Data

4D Radar Solutions and Upstream Suppliers

At present, the main suppliers of single-chip solutions are TI, Arbe, and Uhnder.
TI released AWR2944, its second-generation radar single chip, in January 2022. Compared with the previous AWR1843, AWR2944 adopts a 4T4R solution, which has one more transmitting channel than AWR1843 and can improve angle estimation. The MCU is upgraded from R4F to R5F with dual-core lock step, and the DSP is upgraded from C67x to C66x. HWA (radar algorithm accelerator) iterates from version 1.0 to 2.0, supporting radix-2 and radix-3 FFT, CFAR-OS and data compression. At present, the 4D radars based on this chip include WHST's STA77-5S forward radar and Fusionride's Columbus forward radar series.

Comparison between TI's Single-chip Products



Source: TI

Some 4D Radar Solutions and Upstream Suppliers

Vendor	Product	Release Time	Solution	Partner
Bosch	LRR5 Premium Version	Jan 2021	Four-chip cascade	/
Continental	ARS540	Sep 2020	Four-chip cascade	NXP, Xilinx
WHST	STA77-6	Jan 2021	Two-chip cascade	TI
Magna	ICON	Jan 2018	Single-chip integration	Uhnder
Arbe	Phoenix	2019	Single-chip integration	Self-development
Jingwei Hirain	LRR610	May 2023	Single-chip integration	Arbe
Fusionride	Columbus front/corner radar	Nov 2022	Single-chip integration	TI
Oculii	Eagle	Mar 2021	Dual-chip side-by-side + SAR	TI
Geometrical PAL	Ares Series	2019	SAR	Unknown

Source: ResearchInChina

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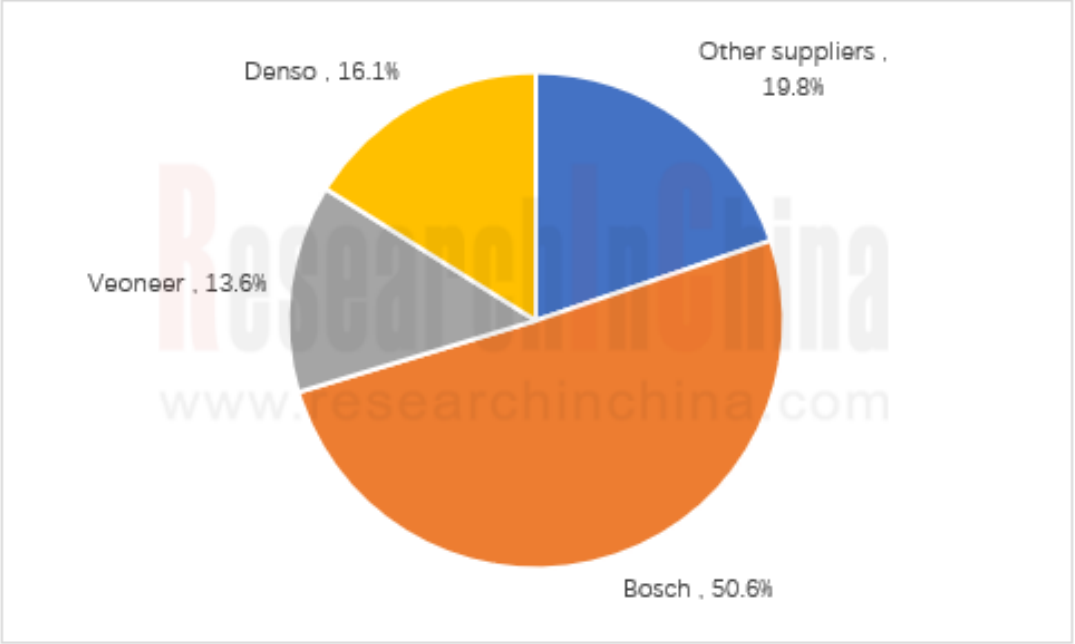
In the infancy of intelligent driving, conventional OEMs give priority to safety, quality and intelligent driving system integration when selecting suppliers, so they will prefer mature brands represented by foreign Tier 1 suppliers like Continental and Bosch which are versed in the automotive field to ensure that their software and hardware meet automotive standards. Foreign suppliers enjoy first-mover advantages and industry influence, so they sweep 90% of the Chinese radar market.

In 2022 and H1 2023, in the Chinese radar market, foreign suppliers took a more than 95% share, among which Bosch, the largest front radar supplier, made up 50.6% of the market in H1 2023, and Hella, the largest corner radar supplier, occupied 49.8% in H1 2023.

TOP3 Front Radar Suppliers in China, 2023H1



Source: ResearchInChina

Some Intelligent Driving Solution Suppliers in China

For Chinese radar suppliers, the key to catching up with and overtaking foreign counterparts lies in technical expertise, qualifications, and mass production experience, so radar suppliers with great technical strength and certain mass production experience gain greater first-mover advantages.

For example, **Nova Electronics** began to develop radars in 2014 and launched its first corner radar in 2018. So far, its products have covered front radars (including 4D radars), corner radars and cockpit radars. At present, the main products include NOVA 77GF-B Plus front radar (mass-produced in Q1 2022), NOVA 77GB-C corner radar (mass-produced in Q2 2021), NOVA 77GB-C Pro corner radar (mass-produced in February 2022), NOVA 77GB-T corner radar (mass-produced in 2022) and 4D imaging radar (launched in 2023 and designated by three OEMs).

WHST, established in 2015, supplied corner radars in small quantities in 2016. In 2018, the STA24-1 corner radar landed in two models, including Leopaard Mattu. Now, its products embrace front radars (including 4D radars), corner radars, cockpit radars, side radars and tailgate radars. The main products include STA 77-5 forward radar (mass-produced in 2021), STA 77-6 4D front radar (mounted on Li L7 Pro and Deepal SL03 in 2023), and STA 77-8 4D front radar (the company built cooperation with first-tier OEMs in China on custom development based on this product in 2022).

Chuhang Tech, founded in 2018, launched its first corner radar - ARC1 in December 2019. At present, its products cover front radars (including 4D radars), corner radars, cockpit radars, and stealth radars (innovative products). The main products include ARF front radar (installed by Neta, Leapmotor and JAC in 2022), ARC corner radar (available in Haima and Leapmotor in 2022), 4D front radar with 6 transmitters and 8 receivers (used by Windrose Technology and an independent new energy vehicle company in 2023), and 4D front radar with 12 transmitters and 16 receivers.

In the future, as technology matures, intelligent driving solutions will head in the direction of lower cost, higher efficiency, supporting services, application and localized delivery. By then, the advantages of domestic radar suppliers will be highlighted. For example, local suppliers such as Huawei and Baidu carry out more flexible market strategies than foreign Tier 1 suppliers. For example, compared with ADS 1.0, Huawei's ADS 2.0 cuts down hardware while improving intelligent driving functions, achieving cost reduction and efficiency improvement. ADS 2.0 has been installed in Avatr 11, AITO M5 and other models, among which the sales of AITO M5 totaled 69,000 units from 2022 to June 2023, with 207,000 radars installed. Yihang.AI's driving-parking integrated and all-scenario solutions also have a big cost reduction, with cost slashed by about 50% compared with other NOA solutions on the market.

Some Intelligent Driving Solution Suppliers in China

Some Intelligent Driving Solution Suppliers in China

Supplier	Product/Solution	Market Strategy	Major Customers	Radar Installations, 2022-Jun 2023
Huawei	ADS 2.0: **3R11V12U1L**	Less perception hardware, lower cost (compared to ADS 1.0, ADS 2.0 reduces the number of LiDARs from 3 to 1, the number of radars from 6 to 3, and the number of cameras from 13 to 11) More intelligent driving functions cater to market demand (adding low-speed emergency braking, emergency braking for special objects, emergency lane keeping, urban lane cruise assist enhancement, sentry mode, etc.)	Avatr, Seres	More than 207,000 units
Yihang.AI	Front view perception solutions: **1R1V, 3R1V, 5R1V** Basic version of driving-parking integration:**5R6V12U** Flagship version of driving-parking integration: **5R11V12U** All-scenario solution: **5R11V12U3L**	Compared with the mass production NOA solutions of other brands on the market, the cost can be reduced by about 50%, and the cost of the whole system is less than RMB10,000. China's popular models priced at RMB150,000 are covered.	Jiangling, Renault, WM Motor, SAIC Maxus, etc.	-

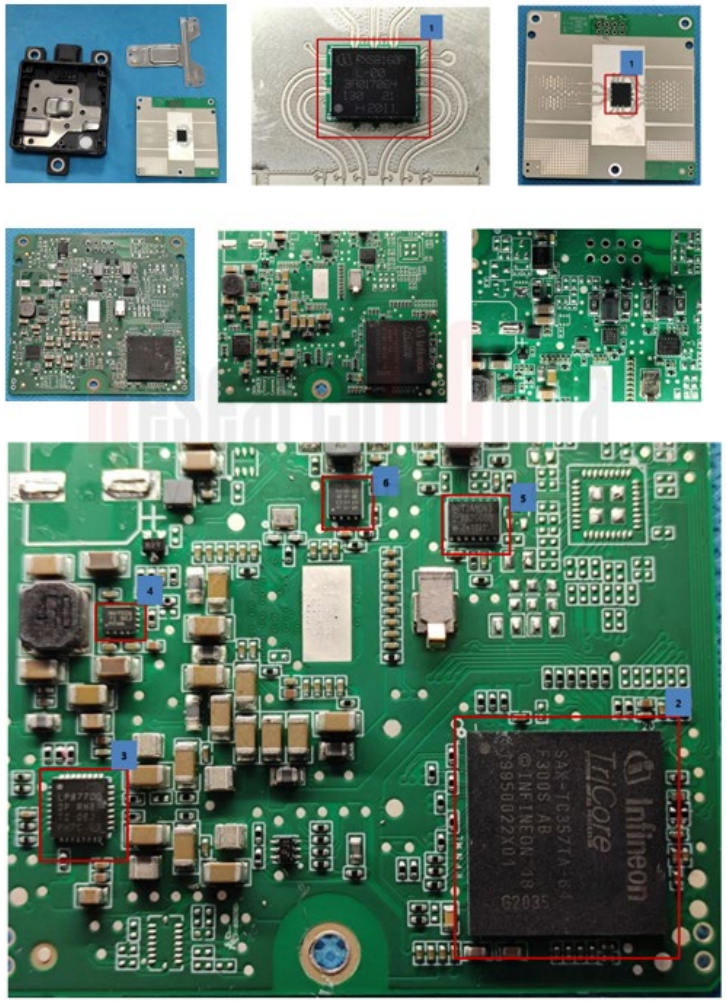
Source: ResearchInChina

Analysis on BOM of Jingwei Hirain's MRR510 front radar

4. Analysis on BOM of Jingwei Hirain's MRR510 front radar

MRR510 is a 77GHz front radar released by Jingwei Hirain in 2022, with the ranging of 0.5-190m, the ranging accuracy of ±0.1m, the HFOV of 90°, the VFOV of 18°, and the side angle accuracy of ±0.5°, and the speed measuring accuracy of ±0.05 m/s. It has been available to SAIC, JAC, Jiangling Ford and other brands. The chip solution has 3 transmitters and 4 receivers, and the upstream suppliers include Infineon, TI and NXP. Referring to the market price, the BOM cost of the known parts of MRR510 is approximately USD35.827.

Disassembly Diagram of Jingwei Hirain MRR510



Source: Public Data

Partial BOM Cost of Jingwei Hirain MRR510

Upstream Product	Disassembly Diagram No.	Model	Supplier	Reference Price
MMIC	1	RXS8160P	Infineon	The unit price for a one-time purchase of 3,000 units is US$16.22.
MCU	2	TC357TA	Infineon	The unit price for one-time purchase of 1,000 units is US$12.8.
PMIC	3	LP8770Q1	TI	The unit price for one-time purchase of 3,000 units is US$1.83.
DC/DC converter	4	LMR36015FSCQRNXRQ1	TI	The unit price for one-time purchase of 3,000 units is US$0.99.
CAN transceiver	5	TJA1043	NXP	The unit price for one-time purchase of 1,000 units is US$0.644.
CAN transceiver	6	TCAN1042V	TI	The unit price for one-time purchase of 1,000 units is US$0.75.
CAN: 8P Connector	-	YAZAKI 7283885530	YAZAKI	The unit price for one-time purchase of 1,000 units is US$1.52.
CAN: Terminal block	-	YAZAKI 7116441502	YAZAKI	The unit price for one-time purchase of 1,000 units is US$0.041.
CAN: Plug	-	YAZAKI 7158316590	YAZAKI	The unit price for one-time purchase of 1,000 units is US$0.032.

Source: ResearchInChina

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