

Global and China Automotive Smart Antenna Research Report, 2022-2023

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Smart antenna research: the integration of automotive antennas and intelligent connected terminals tends to accelerate

The development trend of automotive antennas: tend to be intelligent, diversified and integrated.

Automotive antennas have entered an era of intelligence. OEMs place a higher premium on the application of antenna functions amid V2X and smartphone integration, thereby facilitating the intelligent, diversified, and integrated development of automotive antennas. As new technologies such as 5G and MIMO find application, antenna manufacturers also endeavor to research anti-jamming and all-in-one antenna technologies, that is, ensuring that multiple automotive antennas of different types work normally and independently in multi-antenna integration.

Main development trends of automotive antennas:

* **Intelligent:** integrated with intelligent connected terminals, and applied to ADAS and V2X scenarios, e.g., Continental's shark fin antenna; * **Integrated:** more common in high-end vehicle models, adopt hidden antenna design, and highlight the reinforced anti-jamming performance of different types of antennas, e.g., SPEED's all-in-one antenna;

* **Diversified:** bring antenna functions into full play in different scenarios, and use all-in-one antenna technology, e.g., Glead's multi-mode antenna and YOKOWO's combined shark fin antenna.

Foreign first-tier automotive antenna manufacturers are led by Continental, TE Connectivity, Harada Industry and Ficosa. They use all-inone antenna technology to integrate AM/FM/cellular/GNSS antennas into the shark fin and combine them with intelligent connected terminals. For example, the shark fin antenna provided by Continental for OEMs like Volvo and BMW is integrated with T-Box and uses smart antenna modules to simplify the antenna layout of the car body; Bosch has also developed a smart antenna akin to the T-Boxintegrated smart antenna.

Chinese automotive antenna manufacturers include Harxon, Desay SV, SPEED, Sunway Communication, Lan-You Technology and Neusoft Group. They also master all-in-one antenna development technology, and have the ability to develop smart antennas that can be integrated with intelligent connected terminals. One example is Neusoft Group's C-V2X smart antenna having been mounted on Hongqi E-HS9.



Application of Antenna Products from Major Antenna Manufacturers

Туре	Manufacturer	Product	Whether to Be All- in-one	Whether to Be Integrated With T- Box
	Continental	Shark Fin Antenna	Yes	Yes
	Harada Industry	Shark Fin Antenna	Yes	No
Foreign	YOKOWO	Combined Shark Fin Antenna	Yes	Yes
	Ficosa	Shark Fin Antenna	Yes	Yes
	Denso	Cockpit controller (Model: DNNS117) Built-in Antenna	Yes	Yes
	Bosch	TCU Built-in Antenna	Y <mark>es</mark>	Yes
Chinese	Harxon	Shark Fin Antenna	Y <mark>es</mark>	No
	SPEED	All-in-One Shark Fin Antenna	Yes	No
	Sunway Communication	Vehicle Conformal Antennas	Yes	L.CO Yes
	Lan-You Technology	Vehicle Smart Antenna Terminal	Yes	Yes
	Neusoft Group	T-Box Intelligent In-vehicle Interconnection Terminal	Yes	Yes
	HighGain Information	Smart Connected Antenna	Yes	No
	Glead	Multimode Antenna	Yes	No
	Desay SV	5G V2X Smart Antenna	Yes	Yes

Application of Antenna Products from Major Antenna Manufacturers



Continental Shark Fin Antenna

Continental's new-generation T-Box for Mercedes-Benz, Volvo and PSA is integrated with the shark fin antenna Continental calls BSRF. The figure below is the structure drawing of BSRF: from left to right is BroadR-Reach Ethernet connection, 20-pin master audio connection, and backup battery connection. There is also an FM connection on the other side.

Continental has launched a 5G V2X shark fin antenna as early as 2020. This antenna integrates 5G antenna, V2X antenna (C-V2X and DSRC), and GPS L1/L2 dual-band navigation antenna, enabling rapid transmission of a mass of data.

Distribution of Continental Shark Fin Antenna

Decomposition Diagram of Continental Shark Fin Antenna





BSRF System Architecture



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YOKOWO Antenna

YOKOWO's vehicle antenna products include:

- AM/FM antenna (frequency range: 0.5-110MHz);
- High-precision positioning antenna for L1/L2 and L1/L5;
- Shark fin antenna (customized according to vehicle models);
- GPS antenna
- V2X antenna

Where YOKOWO's vehicle antenna products are installed on a car:

(1) right on the roof;

- (2) rear of the roof (active);
- (3) glass sunroof;
- (4) classic exterior positions, e.g., the front of the car.

Distribution of YOKOWO Antennas



Source: YOKOWO



Harxon

Harxon, a subsidiary of BDStar Navigation, offers 6 types of vehicle antennas, among which shark fin antenna is applicable to L3 /L4 autonomous driving.

In June 2022, Harxon cooperated with Neta Auto on several new model projects, providing intelligent connected vehicle antenna products for Hozon New Energy Automobile. In September 2022, Harxon joined hands with Zhito Technology on application of high-precision positioning and intelligent connection and communication technologies in Zhito's L3 intelligent heavy trucks, including high-precision positioning service, integrated navigation, 5G communication, and V2X communication.

Antenna	Model	Composite Architecture	Application
Intelligent Connected Vehicle Sharkfin Antenna	HX-AUST002	GNSS+LTE+V2X+AM/FM+W IFI+BT	L3, L4
Intelligent Vehicle High-precision Positioning Antenna	HX-AULT006	Support full-band satellite signals from four systems (BDS, GPS, GLONASS and GALILEO)	-
Intelligent Connected Vehicle Cylindrical Antenna	HX-AULT002	Integr <mark>at</mark> e four-system full- band GNSS antenna unit and 5G MIMO antenna unit	
Intelligent Connected Vehicle Glass-shaped Antenna	HX-AUST003	Four-system full-band GNSS antenna unit (outputting 2- channel signals), 5G 1/2/3/4 antenna unit, 7 V2X master and slave antenna units	L3, L4
RSU Integrated Antenna	HX-ACRT001	Three-system 7-band GNSS antenna unit (outputting two-channel signals), 5 5G 1/2/3/4 antenna units	Autonomous Driving
V2X Array Antenna	HX-ACRT002	-	Autonomous Driving

Harxon's Vehicle Antenna Products

Source: Harxon



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Shark fin antenna was developed by BMW in 2001 and initially applied to E65/E66 in the fourth-generation BMW 7 Series. BMW then developed the second-generation shark fin antenna that directly connected the connected driving telematics module and the shark fin base and added a dedicated communication antenna for connected driving. It was used in the new BMW 7 Series models.

At present, the mainstream models in the 1 to 7 Series all use shark fin antennas, and only one model in the I Series and M Series each does not use. BMW's shark fin antenna can integrate GSM antenna, GPS antenna, TCU emergency rescue antenna and DAB antenna (the integrated GSM antenna is used to amplify the phone signals in the car; the integrated GPS antenna is used for vehicle navigation and positioning; the integrated connected driving antenna is used for telecommunication). Its AM/FM antenna is installed at the rear windshield.

BMW Series	Antenna Type	Installation Location	Figure
1 to 7 Series	Shark fin	Rear of the roof	
X1-X7	Shark fin	Rear of the roof	
i3/i4/i7/iX3	Shark fin	Rear of the roof	
M2-M5	Shark fin	Rear of the roof	

Layout of Shark Fin Antennas in Various BMW Models

Source: BMW



Auto brands with high market shares, including Volkswagen, Toyota, Audi, Honda, Buick and Changan, also favor shark fin antennas when choosing antenna solutions, and install them at the rear of the roof.

Auto	Models with Shark Fin Antenna	Models without
Brand		Shark Fin Antenna
POLO, Santana, ID Series, Lamando, Passa Phideon, T-Cross, Tharu, Tiguan, Teramont Touran, Viloran, Bora, Golf, Sagitar, Magotar Tacqua, T-ROC, Tayron, Talagon, Tavendor, Variant, Touareg, etc.		UP! (whip antenna), FOX, etc.
Toyota	YARIS L, Camry, C-HR, Frontlander, Wildlander, Highlander, Venza, Sienna, Allion/Avalon, IZOA, RAV, Crown Kluger, Harrier, Granvia, Crown, Alphard, Vellfire, etc.	YARiS L, Levin, Levin GT, Vios, etc.
Au <mark>di</mark>	A Series, Q Series, S Series, mo <mark>st</mark> RS Series models	RS e-tron GT
Honda	LIFE, Civic, Envix, Inspire, CR-V, XR-V, Fit, Crider, Integra, Accord, ZR-V, Vezel, Breeze, etc.	e: NS1, UR-V, Elysion, Avancier, Odyssey, etc.
Buick LaCrosse, Verano, Electra E4/5, Encore, Regal, Velite, Envista, Envision, GL6/8, Century, etc.		Excelle (whip antenna), Excelle GT
Changan	Yuexiang, Raeton, Benben E-Star, EADO, etc.	Lamore (hidden antenna) etc.

Installation of Shark Fin Antennas by Auto Brands

Source: These Auto Brands



Unlike conventional automakers using shark fin antennas, emerging carmakers prefer differentiation when selecting smart antennas. Among them, NIO chooses a camera-equipped shark-fin antenna structure as the smart antenna solution for its new models; Xpeng Motors and Li Auto integrate smart antennas into the roof rack and spoiler, respectively, for the latest models to make them look more sleek-framed; Tesla chooses to integrate the antenna module into the crossbar of the car body to further simplify the antenna layout.

Carmaker	Model	Installed Antenna Solution	
Tacla	Madal 2/V	Antenna module at the B-pillar	
Tesia	Model 3/1	crossbar, etc.	
NIO	ES7/8, ET7/5, Camera-equipped shark fin		
NIO	EC7	antenna structure on the roof	
Xpeng	WWWG9Sear	Roof rack	
Li Auto	ONE	Roof shark fin	
LI AULO	L7-L9	Rear spoiler	

Installation of Antenna Solutions by Some Emerging Carmakers



WiFi/4G LTE Antenna Module on Model 3/Y

New Tesla Model 3/Y has placed WiFi and 4G LTE antennas in crossbar in the middle of the sunroof above the B-pillar; the GPS antenna module of Model 3 is located above the interior rearview mirror in the same space as the camera module.





NIO ES7/8, ET7/5, and EC7 are all equipped with a shark fin antenna structure (with a camera) at the rear of the roof and above the trunk. For example, the shark fin antenna of ES7/8 integrates a rearview driving assistance camera and 5G communication module; the shark fin antenna structure of ET7/5 highlights camera design in appearance.

Xpeng G9 uses a hidden 5G antenna

and integrates it into the roof rack. This antenna can support high-speed data

transmission for the car.



Source: NIO



Source: Xpeng Motors

Li Auto ONE packs a shark fin antenna, while the automaker switches to a spoiler-integrated antenna for models from L7 to L9. The antenna accessories for the L7 to L9 models are all provided by SPEED, including 5G antenna, highprecision positioning antenna and radio amplifier. Li Auto L9's Bluetooth antenna can sense both horizontal/vertical coordinates and height of the user's smartphone.



Source: Li Auto



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