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Passenger Car Intelligent Steering Industry Research Report, 2024

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Intelligent Steering Research: Steer-by-wire is expected to land on independent brand models in 2025

The Passenger Car Intelligent Steering Industry Research Report, 2024 released by ResearchInChina summarizes and studies the status quo, installation, suppliers' layout, supply chain layout, etc. of intelligent steering in the world and China, and predicts the future development trends of intelligent steering.

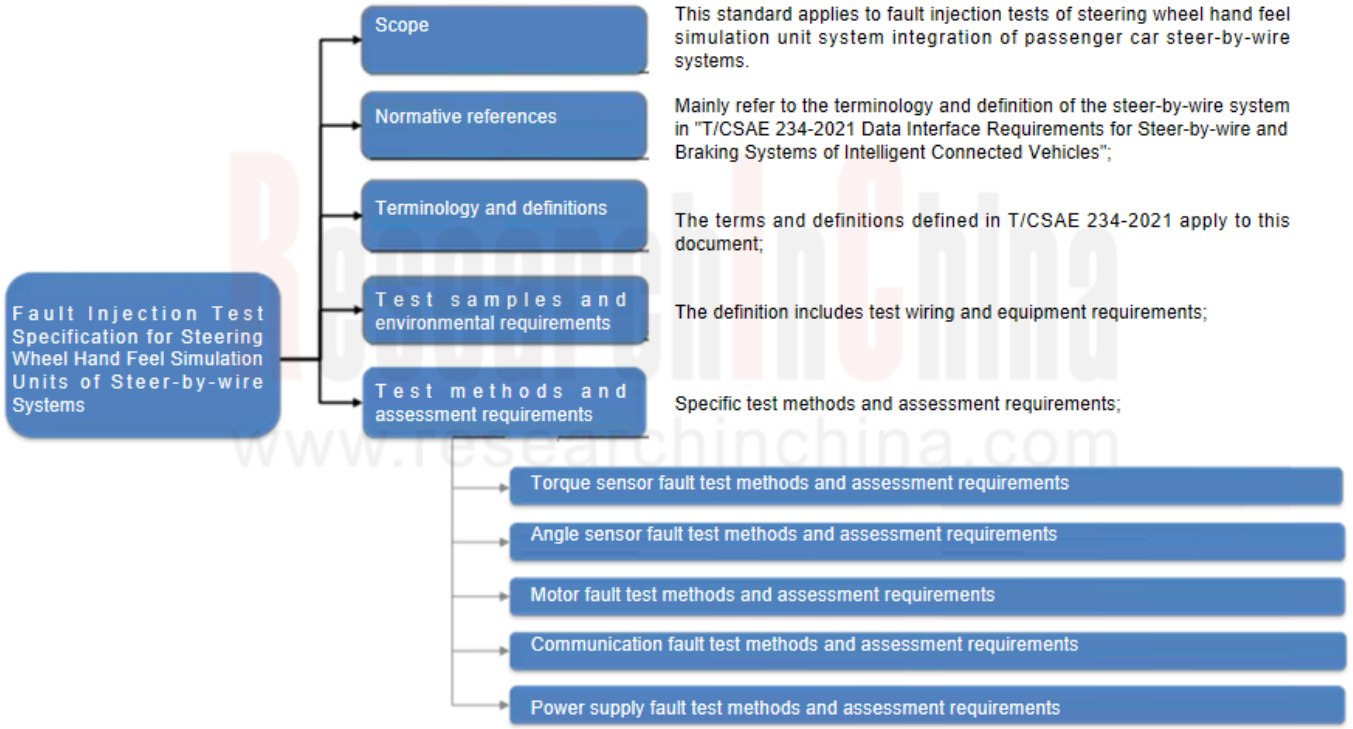
1. Policies provide continuous support, and standards concerning steer-by-wire are becoming definite.

Since 2023, China has formulated a range of national standards, association standards and other policies for steer-by-wire. From system standards such as technical requirements and test methods for steer-by-wire of commercial vehicles and passenger cars, to component standards for wheel hub/wheel rim motors and steer-by-wire road sense simulators, the standards for steer-by-wire are becoming increasingly definite and perfect.

Take the steer-by-wire road sense simulator as an example: when the driver drives a vehicle, the hand feel is very important to the driver. The road sense transmits the force and road conditions of the tires, road surface, and body to the driver through the steering wheel in real time. Without mechanical connection, the road sense can only be produced by the steer-by-wire road sense simulator. The most important function of a road sense simulator is to simulate and restore the driver's feelings as realistically as possible under different road conditions.

In August 2024, the Institute of Electrical Engineering (IEE) of Chinese Academy of Sciences (CAS) and HYCET EPS System (Jiangsu) jointly took the lead in drafting the CSAE standard "Fault Injection Test Specifications for Steering Wheel Hand Feel Simulation Controllers of Passenger Car Steer-by-Wire Systems", a standard which filled the gap in this field.

Main Contents of Steer-by-Wire Hand Feel Simulation Controller Standard



Source: China Society of Automotive Engineers

Steer-by-wire standards and policies, 2023-2024

Summary of Steer-by-Wire Standards and Policies, 2023~2024

	Time	Issued by	Policy	Details	Progress
National standards	April 2024	State Administration for Market Regulation (SAMR), Standardization Administration of the People's Republic of China (SAC)	GB/T 43947-2024 General Technical Requirements for Chassis-by-wire of Low Speed Automated Vehicle	Provisions are made on the overall requirements and response capabilities of low-speed chassis-by-wire systems.	To be implemented in November 2024
Association standard	October 2023	Chinese Association Standard	T/ZJSAE 014-2023 General Technical Requirements for Distributed-drive Control-by-Wire Chassis	Requirements for chassis-by-wire with the wheel hub/wheel rim motor as the only power source	Implemented since October 2023
	October 2023	Chinese Association Standard	T/ZJSAE 015-2023 Technical Requirements and Test Methods of Integrated Electric-hydraulic Steering Gear Controlled by Wire for Commercial Vehicles	Suitable for wire-controlled electro-hydraulic steering gears of commercial vehicles	Implemented since October 2023
	May 2024	Chinese Association Standard	T/GAEPA 003-2024 Steer-by-wire Technical Requirements and Test Methods	System performance and functional requirements for steer-by-wire of passenger cars are determined	Implemented since June 2024
	July 2024	Chinese Association Standard	T/ZJSAE 020-2024 Technical Requirements and Test Methods for Hand Wheel Actuator of Steer-by-wire	Basic performance requirements, strength requirements, and durability requirements	Implemented since August 10, 2024
Others	June 2023	Five departments including the Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Opinions on Improving Manufacturing Reliability	The automotive industry focuses on chassis-by-wire systems such as steer-by-wire, brake-by-wire, automatic gear shift, electronic throttles, and suspension systems.	-
	November 2023	Four ministries and commissions including the Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Notice on the Pilot Program for Admittance and Road Access of Intelligent Connected Vehicles	China has officially allowed the compliant production and road tests of autonomous vehicles, which will greatly promote the application of chassis-by-wire technology and related components.	-
	December 2023	National Development and Reform Commission of China	Guidance Catalogue for Industrial Structure Adjustment (2024)	EPS, steer-by-wire systems, idle start-stop systems, high-efficiency and high-reliability electromechanical coupling systems, electric brake, electric steering and related key components, ESC, and chassis-by-wire systems are encouraged	Implemented since February 1, 2024
	June 2024	Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Key Points of Automotive Standardization in 2024	Promote research on standards for steer-by-wire and brake-by-wire, etc., and actively participate in the revision of technical regulations such as the UN/WP.29 chassis-by-wire (EMB)	-
	July 2024	Automotive Steering Technology Branch of China Society of Automotive Engineers	The CSAE Standard "Technical Requirements and Test Methods for Passenger Car Active Rear Wheel Steering Gear Assembly"	This standard aims to sort out the terms and definitions of active rear-wheel steering of passenger cars and clarify the technical requirements and test methods for active rear-wheel steering assembly of passenger cars.	A kick-off meeting was held in July 2024
	August 2024	Institute of Electrical Engineering (IEE) of Chinese Academy of Sciences (CAS), HYCET (Jiangsu)	The CSAE standard "Fault Injection Test Specification for Steering Wheel Hand Feel Simulation Controllers of Passenger Car Steer-by-wire Systems"	The standard will cover multiple aspects of the steering wheel hand feel simulation units of passenger car steer-by-wire systems, and clearly guide the functional safety verification hereby.	The project was approve and the draft is numbered 2024-046
	August 2024	China Automotive Standardization Institute	The Automotive Chassis-by-Wire Standard Research Group held a special meeting on steer-by-wire	Based on the discussion at the meeting, the standard research group will continue to improve the requirements for performance, functional safety, failure degradation and so on of the steer-by-wire technology, conduct research on the requirements for key data recording of steer-by-wire vehicles, and accelerate the research process of steer-by-wire standards.	-

Many OEMs are vying to deploy steer-by-wire technology which is expected to be available in domestic independent brand models in 2025

There are fewer than 10 passenger car models equipped with steer-by-wire in the world, including Infiniti Q50, Q50L, QX50, Q60, Toyota bZ4X, Lexus RZ, and Tesla Cybertruck. The following table lists the models that have carried and are scheduled to carry steer-by-wire:

Seen from the plans of OEMs, steer-by-wire is expected to be available in domestic independent brand models in 2025.

Summary of Models That Have Carried and Are Scheduled to Carry Steer-by-wire

	OEM	Model	Year	Steer-by-wire technology	Supplier
Models That Have Carried Steer-by-wire	Infiniti	Infiniti Q50	2013	Steer-by-wire DAS (with mechanical redundancy)	KYB
	Infiniti	Infiniti Q50L, QX50, Q60	2018	Steer-by-wire DAS 2.0 (with mechanical redundancy)	KYB
	Toyota	Toyota BZ4X (overseas version)	2022	Steer-by-wire One Motion Grip (no mechanical connection between the steering wheel and the front wheels)	JTEKT
	Lexus	Lexus RZ	2022	Steer-by-wire variable ratio electronic steer-by-wire system + special-shaped steering wheel	-
	Tesla	Cybertruck	2024	Steer-by-wire, rear-wheel steering	ZF
	Audi	R8 LMS GT2 (racing car)	2024	Mechatronic rear-wheel steering system, Space Drive steer-by-wire system	Schaeffler
Models That Are Scheduled to Carry Steer-by-wire	Tesla	Model S&X	2024 (expected)	It is expected that these two new models will be equipped with steer-by-wire and matched with Yoke steering wheels in 2024.	-
	NIO	ET9	2025 (expected)	This model will be equipped with the NIO SkyRide chassis system for the first time (composed of three core components: steer-by-wire, rear-wheel steering and fully active suspension). NIO ET9 is expected to be officially launched in September 2024 and will be delivered in the first quarter of 2025.	-
	Audi	skysphere (concept car)	2025 (expected)	Equipped with steer-by-wire technology and rear-wheel steering technology, it is expected to be mass-produced in 2025	-
	Mercedes-Benz	Battery-electric EQS, next-generation S-Class	2027 (expected)	The special-shaped steering wheel and steer-by-wire system will be put into use as early as 2027, and will be used in the next-generation Mercedes-Benz S-Class, EQS and other models.	-

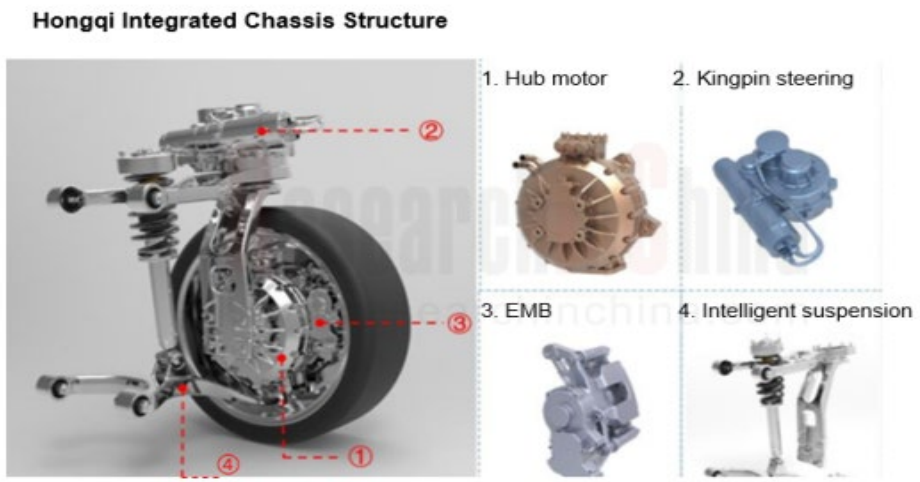
Source:ResearchInChina

Four-wheel independent steering will be the future development direction of steer-by-wire

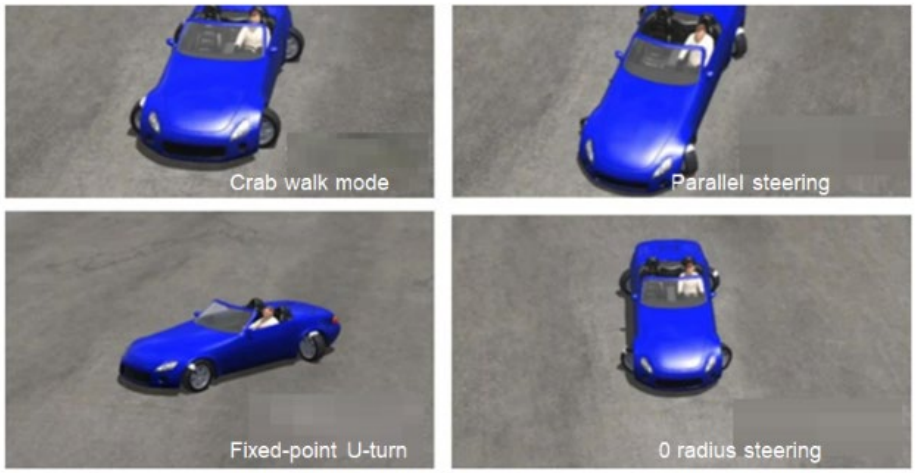
The 4-wheel steering with steer-by-wire system (4WS-SBW) is composed of an independent mechanical transmission mechanism and a steering actuator motor. Each wheel can independently control the steering angle, enabling the vehicle to turn in place while increasing the freedom of driving attitude. The greatest significance of 4-wheel independent drive lies in safety. It can improve the stability and anti-skid control of the vehicle. It also provides power and steering dual redundancy for the autonomous driving system. Even if the steering wheel fails, steering can be achieved through the speed difference between the four wheels.

For example, the Hongqi integrated chassis structure comes from the "Hongqi drive-steering integrated power chassis" technology of the intelligent driving safety chassis system of the e.RFlag electric platform (HME). This chassis technology platform pioneered a chassis domain control algorithm to achieve integrated control of steering, braking and suspension systems. It removes the motors that drives the wheel from the body, integrates them directly into the wheel, and installs them on the inside of the wheel hub instead. All four wheels adopt the same design. This is equivalent to directly canceling the transmission devices on traditional vehicles, allowing the wheels to drive "themselves", and realizing seven motion modes including crab walk steering, fixed-point U-turn, front-wheel steering, and four-wheel steering.

Hongqi Integrated Chassis Structure



Hongqi's Integrated Chassis Structure Enables Steering



Source: Sohu Auto

Layout of OEMs and Suppliers in 4-wheel Independent Steering

BYD, Hongqi, Dongfeng and Schaeffler among others have laid out 4-wheel independent steering, a technology which is a major future development direction of steer-by-wire.

Layout of OEMs and Suppliers in 4-wheel Independent Steering

Company	4-wheel Independent Steering Layout	SOP
BYD	All models under the Yangwang brand will be equipped with e4 technology which connects 4 wheels through 4 wheel rim motors to drive a single wheel separately without relying on steering gears or tie rods, allowing the vehicle to make a U-turn on the spot.	2023 (available on U8 and U9)
Hongqi	The integrated chassis structure realizes integrated control of steering, braking, and suspension systems, and can fulfill seven motion modes including crab walk steering, fixed-point U-turn, front-wheel steering, and 4-wheel steering.	Expected in 2025
Dongfeng	4WS-SBW is expected to be realized after 2025.	After 2025
Schaeffler	The intelligent steer-by-wire angle module integrates Schaeffler's wheel hub motors to achieve 90-degree 4-wheel independent steering	-
HYCET	Pre-research on advanced technologies such as 4-wheel independent steering and XYZ three-way collaborative domain control.	-
Zhejiang Shibao	The funds raised from the private placement will be largely spent on R&D of intelligent automotive steer-by-wire, automotive 4WS-SBW and high-safety steering control modular design technologies.	-

Source:ResearchInChina

Steer-by-wire technology will disrupt cockpit design

Change 1: Steer-by-wire can enable foldable steering wheels to increase the available space in the cockpit. Nexteer's steer-by-wire can realize a foldable steering wheel, which automatically retracts during autonomous driving to increase the available space in the cockpit. ZF's steer-by-wire will allow the steering wheel to automatically retract in the future.

Nexteer's Steer-by-wire Enables Foldable Steering Wheels

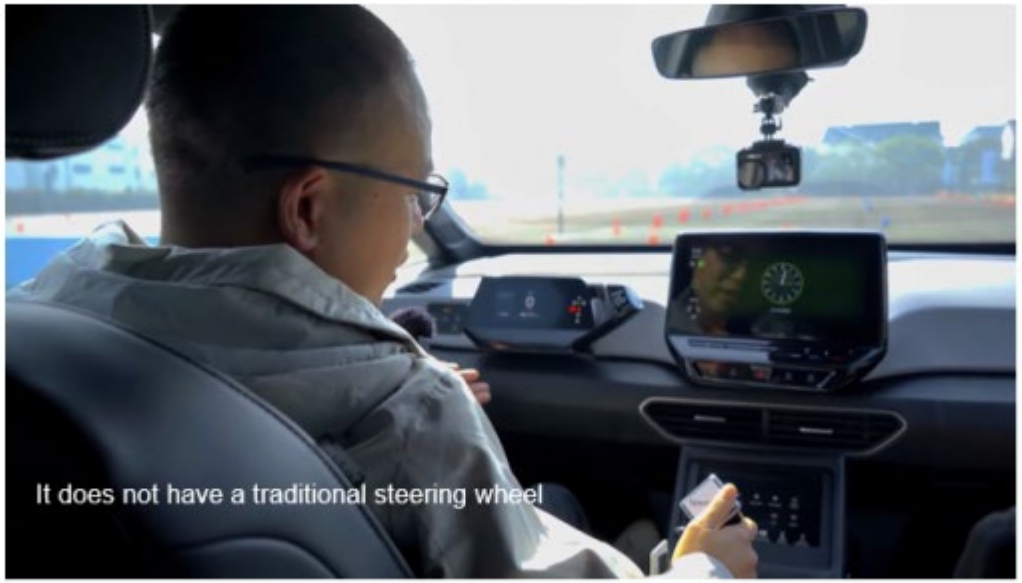
Source: Nexteer

Steer-by-wire technology will disrupt cockpit design

Change 2: Steer-by-wire technology can eliminate the steering wheel and replace it with other devices:

In November 2023, Schaeffler announced its force feedback operating joystick technology, which cancels the traditional steering wheel and replaces it with a joystick placed next to the armrest. Schaeffler's force feedback operating joystick has no mechanical connection with the front steering mechanism. This joystick can clearly feed the road sense back to the driver. The full steering stroke is about 100 degrees from the left to the right. The entire system development meets the relevant functional safety requirements and standards.

Schaeffler Canceled the Traditional Steering Wheel and Replaced it with Force Feedback Operating Joystick Technology



Source: Schaeffler

Hitachi Astemo Smart SBWS

Hitachi Astemo Uses A Mouse to Control the Steering Wheel in the Central Armrest

In May 2024, Hitachi Astemo's Smart SBWS used multiple control solutions to replace the traditional steering wheel, for example, using a mouse to control the steering wheel in the central armrest box, or using a new device on the left side of the front passenger to control the steering wheel. The system is expected to be mass-produced in 203X.

Hitachi Astemo Designs A New Device on the Left Side of the Front Passenger to Control the Steering Wheel

Source: Hitachi Astemo

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Contact

Beijing Headquarters

TEL: 13718845418
Email: report@researchinchina.com

Website: ResearchInChina

WeChat: Zuosiqiche

Chengdu Branch

TEL: 028-68738514
FAX: 028-86930659

zuosiqiche