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DENSO CASE (Connectivity, Automation, Sharing and Electrification) Layout Research Report, 2022

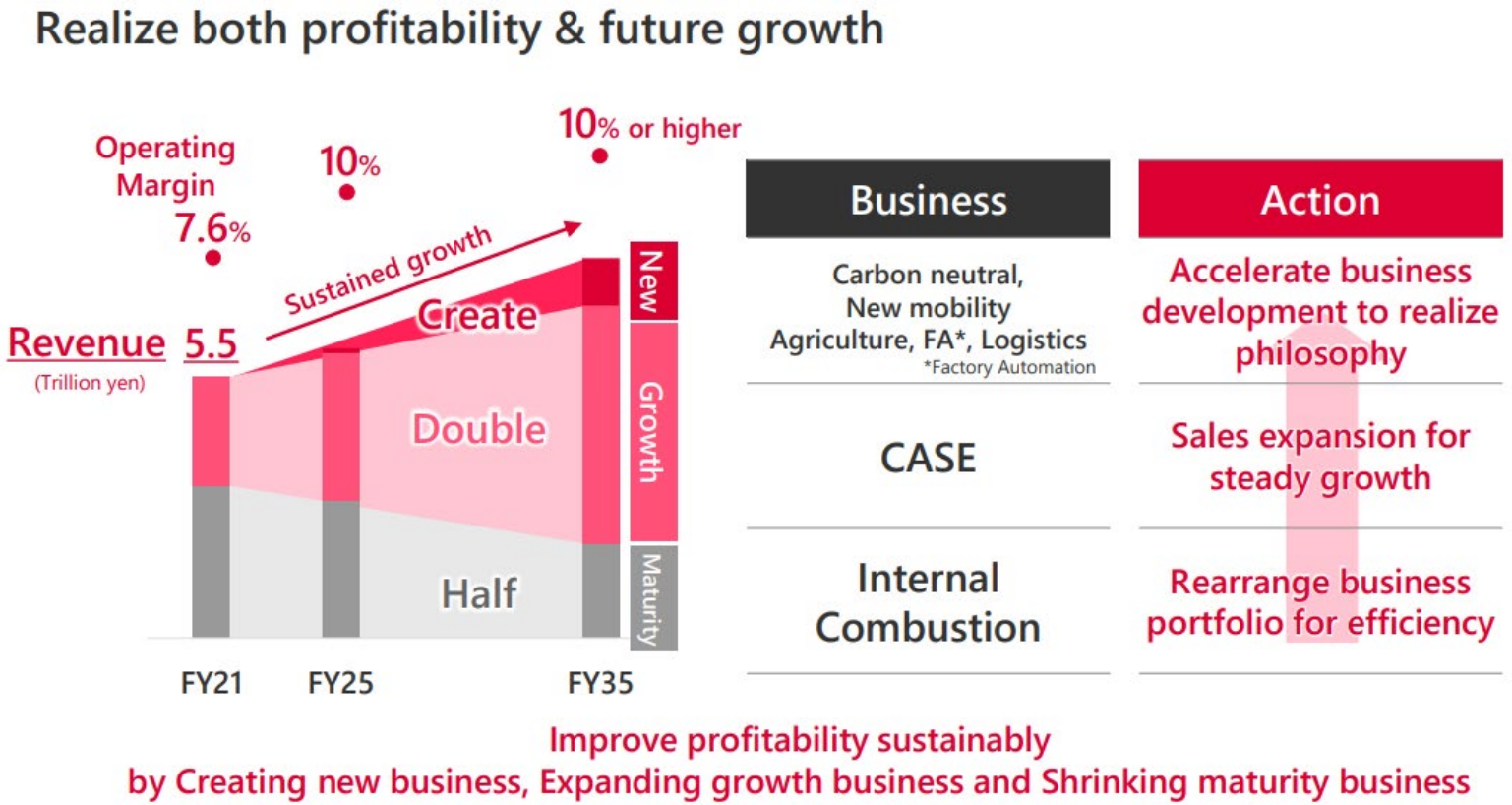
June 2022

DENSO CASE Research: The semiconductor business will help it go "from Toyota to the world”

ResearchInChina has released DENSO CASE (Connectivity, Automation, Sharing and Electrification) Layout Research Report, 2022 to sort out and study the layout of Japan-based DENSO Group in the fields of automation, connectivity, electrification and other fields, summarize its development dynamics in 2021-2022 and predict its future business focus.

1. DENSO's future growth will mainly hinge on CASE

With the transformation and development of CASE, DENSO has built relatively sound technical capabilities in the fields of automation, connectivity, and electrification, and its future growth will mainly hinge on CASE.



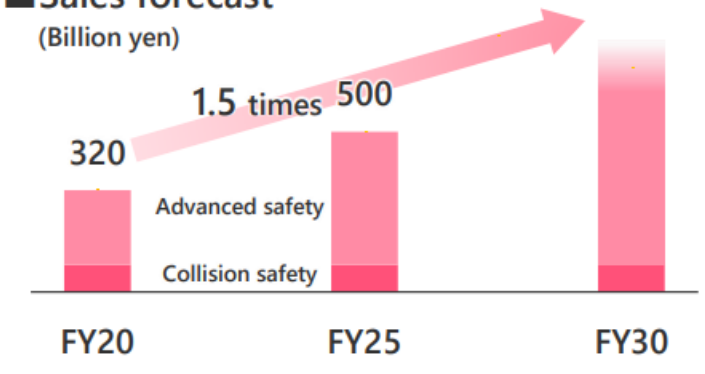
DENSO's future growth will mainly hinge on CASE

In the field of automation, DENSO has formed ADAS (L2-L4), surround-view systems, AVP, autonomous platooning, autonomous taxis, a series of active safety systems, AD systems and ADAS through the provision of cameras (front-view monocular/binocular, surround-view), radar (forward, corner), LiDAR, ultrasonic radar, integrated control software for autonomous driving and other products. In addition, it provides users with integrated software and hardware solutions.

At this stage, DENSO mainly applies the autonomous braking function to the front, rear, left and right directions, and to avoid traffic accidents in scenarios such as crossing intersections. In the future, DENSO will strengthen the development of early warning functions with the help of V2X and other infrastructure.

Sales expansion in growth area (ADAS)

■Sales forecast



<Product lineup>

Advanced Driving Support System	Parking suport	Autonomous driving
Vision sensor, Millimeter-wave, Driver monitor, V2X	Sonar, Sonar ECU, Surround monitoring ECU	LiDAR, ADS/ADX ECU, SIS ECU

■Differentiation strategy of AD/ADAS

✓ Wide product lineup which is possible to cover various accident scenes

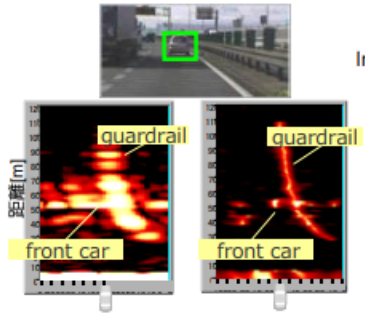
Eliminate traffic accidents by automatic braking Prevention by warning notice

✓ Original technology for promotion

High recognizing performance of night camera

Install Lexus LS（2017）

Original Millimeter-wave recognizing algorithm



High-accuracy detection by fusion of sonar and camera

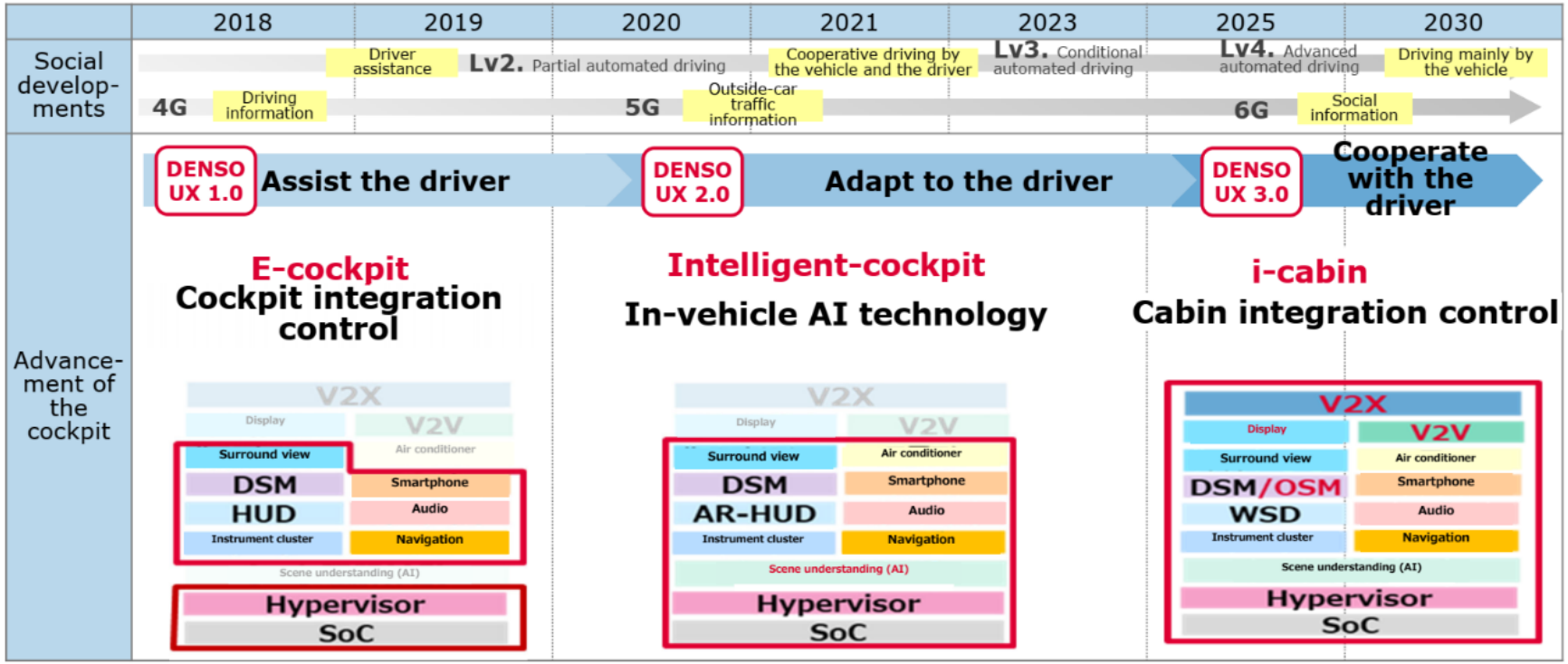
Install TOYOYA YARIS（2020）

Grow by wide product lineup and original technology against ADAS market expansion

Connectivity

In the field of connectivity, DENSO's products cover automotive communication, IVI systems, digital keys, OTA solutions, cyber security solutions, cockpit domain control platforms, clusters & center consoles, HUD, DMS, etc. Among them, automotive V2X communication equipment features wireless communication, vehicle positioning and status judgment, and it enables safe driving assistance through wireless vehicle-to-vehicle and road-vehicle communication. It has been installed in Toyota Prius, Crown, Lexus RX, Lexus LS and other models. DENSO plans to integrate V2X, V2V, display systems, DMS/OMS and other functions into the bottom layer of cockpit to offer a more intelligent cockpit solution by 2025.

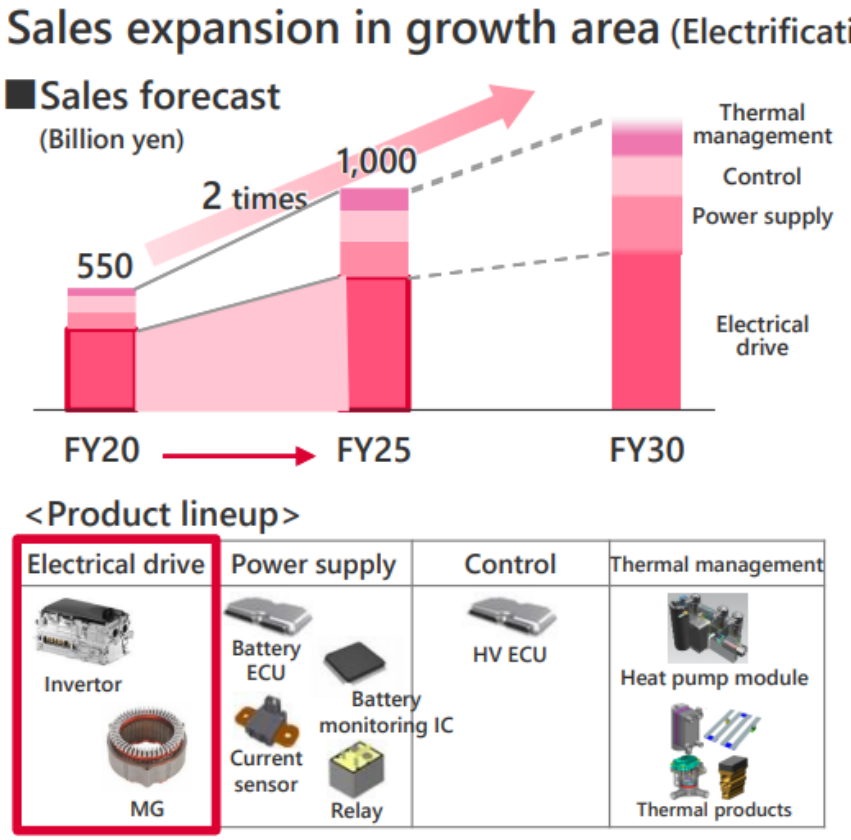
Roadmap for the cockpit system

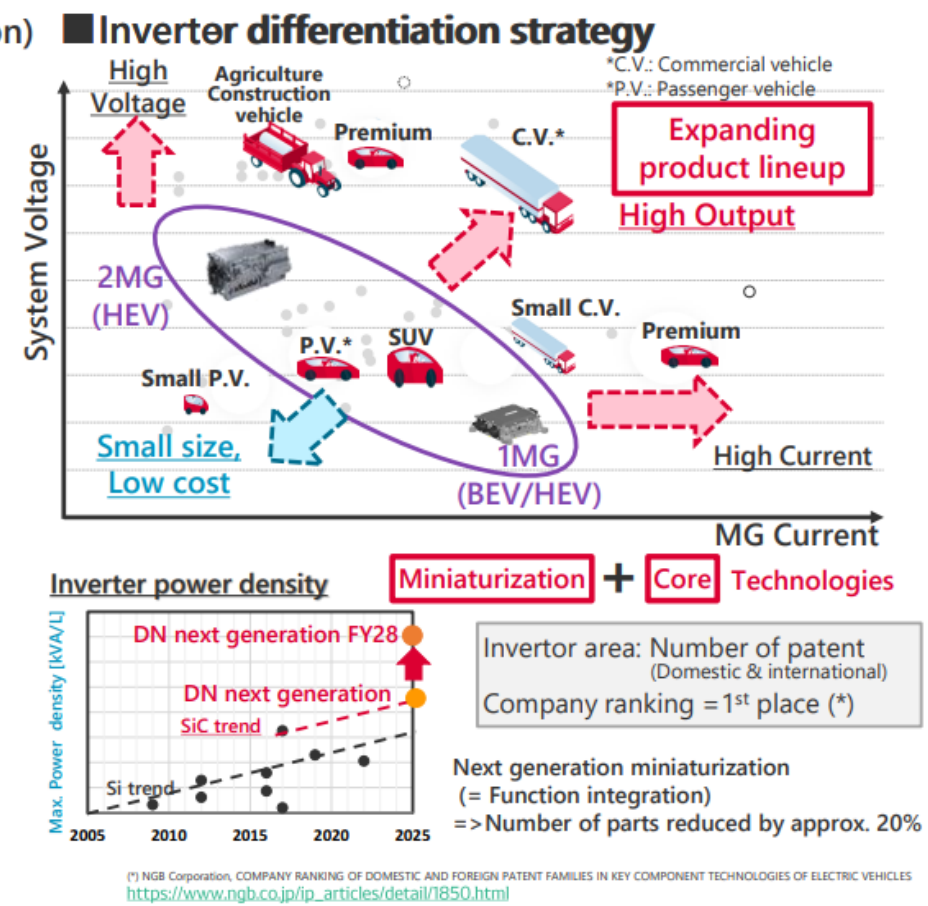


Offer cockpit systems that support the driver in line with the advancement of vehicles

Electrification

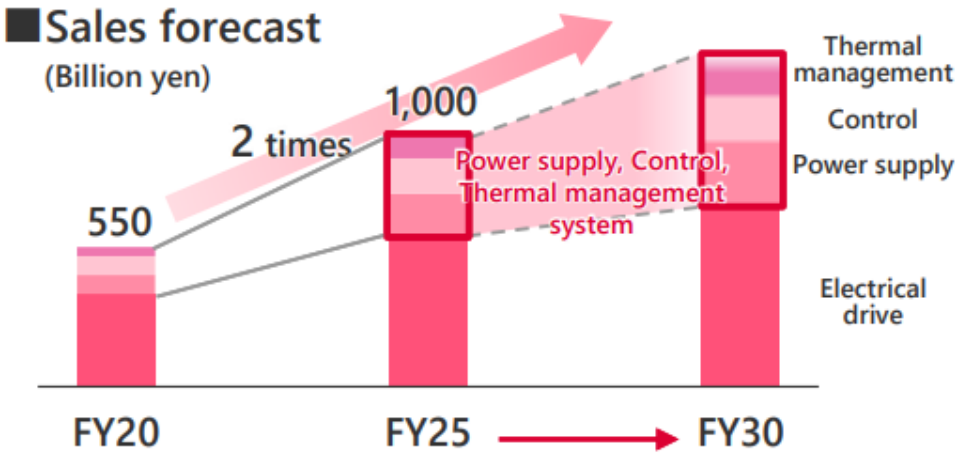
In the field of electrification, DENSO focuses on the development of core products across electrified powertrain platforms (PHEV, HEV, BEV, FCEV): battery packs, motors, inverters, and energy management systems.
According to the plan, DENSO will center on the development of inverter and stator winding technologies before 2025, extend to power modules, control modules and thermal management systems from 2026 to 2030, and further enhance its supply chain.





Sales expansion in growth area (Electrification)

■Sales forecast



<Product lineup>

Electrical drive	Power supply	Control	Thermal management
Invertor, MG	Battery ECU, Battery monitoring IC, Current sensor, Relay	HV ECU	Heat pump module, Thermal products

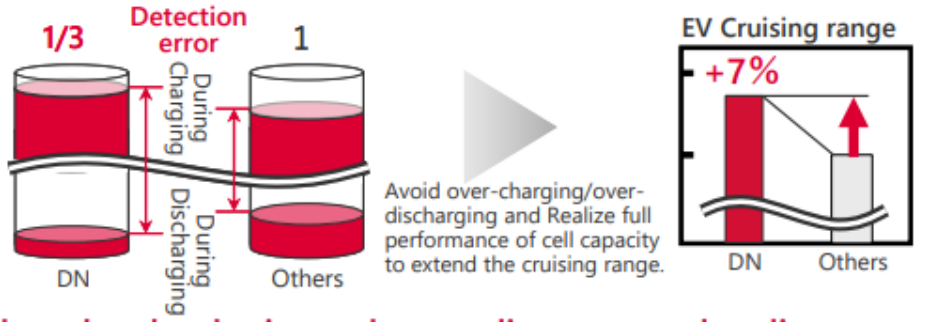
■Battery system differentiation strategy

✓ **Safety & efficient control** on a wide variety of batteries

	ECU	Battery monitoring IC	Current Sensor	Relay	Module	Battery Cell
System Configuration	SW					
DENSO						
Battery Supplier		*Only Battery				
ECU Supplier						

✓ **Unique technologies** extending the cruising range

Battery monitoring IC: High accurate monitoring on cell capacity with low detection error



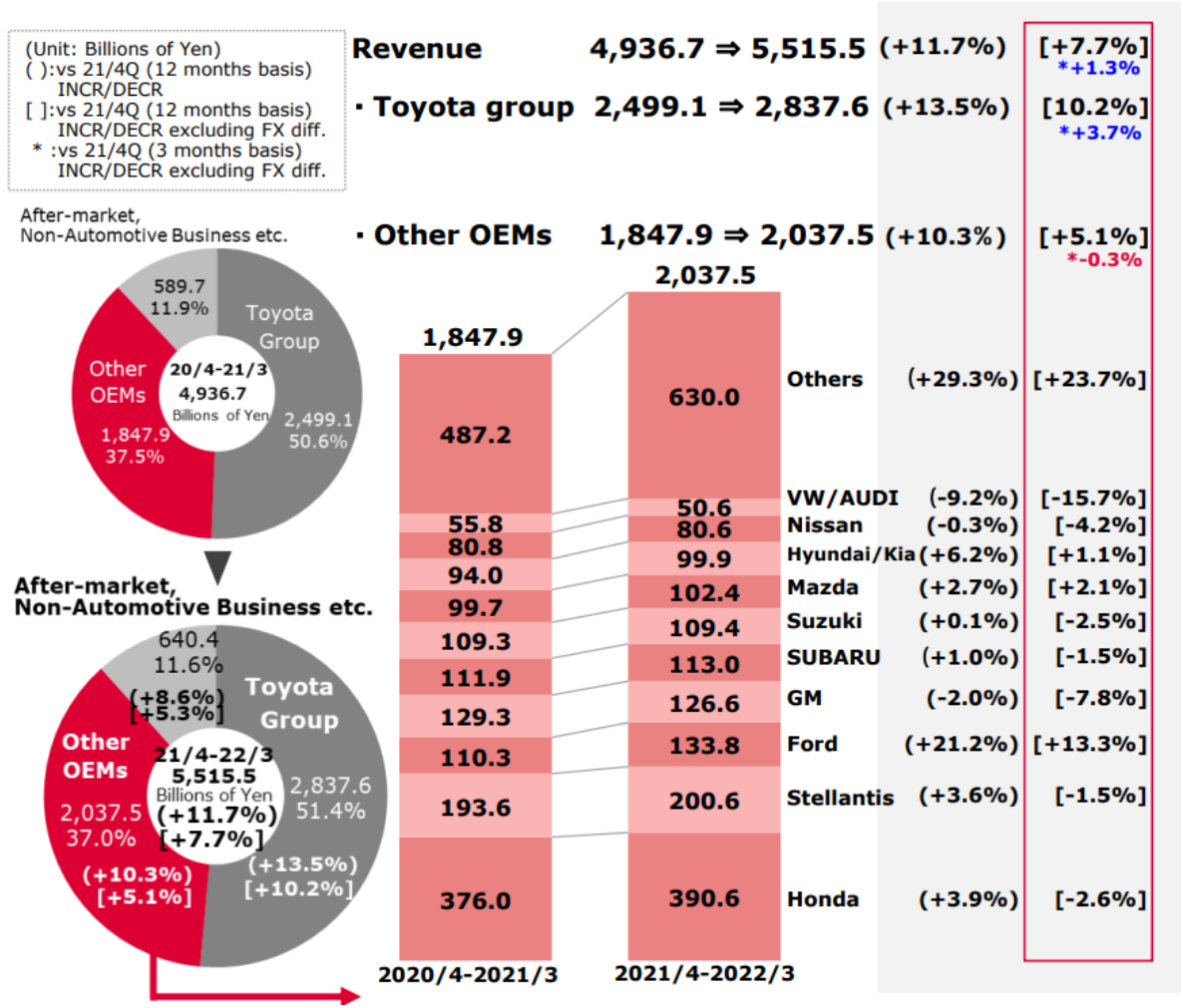
Realize both environment & biz. growth by further deepening developed technologies and expanding our product lineup

Toyota contributes over 50% to DENSO's revenue

After DENSO was separated from Toyota in 1949, the two have maintained an amicable and cooperative relationship. In FY2022, Toyota contributed 51.4% to DENSO's revenue, an increase of 0.8 percentage point from the previous fiscal year; the order intake worth JPY2,837.6 billion, up 13.5% year-on-year.

DENSO's CASE products are mainly tested and mass-produced through Toyota. For instance:

- In April 2021, DENSO announced it had developed products for Advanced Drive, an advanced driver assistance technology featured on the new Lexus LS and the new Toyota Mirai. DENSO's newly developed products used in Advanced Drive include LiDAR, a binocular vision system, an Spatial Information Service Electronic Control Unit (SIS ECU), an Advanced Drive System Electronic Control Unit (ADS ECU) and Advanced Drive Extension Electronic Control Unit (ADX ECU).
- In May 2022, BluE Nexus Corporation, AISIN Corporation, and DENSO Corporation announced that they had jointly developed eAxle for Toyota's new battery electric vehicle (BEV), bZ4X.



DENSO's layout concentrates on the semiconductor field

In 2022, DENSO's layout concentrates on the semiconductor field.

In February 2022, DENSO acquired a more than 10% stake in Japan Advanced Semiconductor Manufacturing, Inc. (JASM), TSMC's majority-owned manufacturing subsidiary in Kumamoto Prefecture, Japan. With this equity investment, DENSO became JASM's third largest shareholder. TSMC will build a new chip factory in Kumamoto Prefecture, Japan through JASM to produce cutting-edge logic semiconductors for image sensors and MCUs, with mass production scheduled to begin by the end of 2024. The acquisition will enable DENSO to stably purchase cutting-edge semiconductors with circuit line widths of around 10-20 nanometers in Japan.

In February, DENSO announced that it will increase its annual inverter capacity to 10 million units by FY2025 (ending in March 2026), tripling the current level. In order to achieve this goal, DENSO will expand or build new factories in Japan, the United States, China, Europe, Southeast Asia, India and other countries and regions. In addition to supplying products to Toyota, it will contact European and American OEMs.

In April 2022, DENSO and United Semiconductor Japan Co., Ltd. (USJC), a subsidiary of global semiconductor foundry United Microelectronics Corporation (UMC), announced that they had agreed to collaborate on the production of IGBTs at USJC's 300mm fab. The production is scheduled to start in the first half of 2023.

"DENSO is considering spinning off its JPY420 billion chip business", CTO Yoshifumi Kato said in an interview in June 2022.

DENSO's CASE Cooperation

DENSO's CASE Cooperation Dynamics, 2021- 2022

January 2020	DENSO and Qualcomm Technologies, Inc., a subsidiary of Qualcomm Incorporated, announced the companies' joint efforts in developing next-generation cockpit systems.	Connectivity layout
November 2020	DENSO invested in Lambda:4 to strengthen its passive digital key, increasing its location accuracy and user authentication capabilities.	Connectivity layout
November 2020	DENSO announced it had taken a stake in Envoy Technologies, an electric vehicle startup	Electrification layout
December 2020	DENSO announced it had begun mass production of its latest model of booster power module equipped with high-quality silicon carbide (SiC) power semiconductors for fuel cell vehicles. DENSO developed a new in-vehicle SiC transistor, and this marks the first time DENSO has used SiC for in-vehicle diodes and transistors.	Electrification layout
January 2021	Aeva collaborated with DENSO to advance Frequency Modulated Continuous Wave (FMCW) LiDAR.	Automation layout
January 2021	DENSO invested in Dellfer. The investment will help accelerate the development and distribution of Dellfer's best-in-class cybersecurity solutions for the automotive industry.	Connectivity layout
November 2021	SemiDrive and DENSO Kotei jointly released the X9U e-cockpit platform. The mass production will begin in 2023. It will assist customers in the research and development of cockpit domain controllers.	Connectivity layout
March 2021	DENSO and KDDI jointly began researching 5G's use in automated driving.	Automation layout
April 2021	DENSO developed new products for Advanced Drive, an advanced driver assistance technology featured on the new Lexus LS, released in Japan on April 8, 2021 and the new Toyota Mirai, released in Japan on April 12, 2021.	Automation layout
May 2021	Aeva had deals with DENSO and ZF Friedrichshafen AG for mass production of its sensors.	Automation layout
June 2021	DENSO, Audi, Arm, NXP, etc. joined the autonomous driving development technology community "The Autonomouse"	Automation layout
June 2021	DENSO signed a long-term agreement with aerospace leader Honeywell, establishing an alliance focused on electric propulsion units to meet new aerospace needs. The companies will develop and manufacture electric propulsion systems for aircraft, initially prioritizing the urban air mobility (UAM) segment with a focus on air taxis and delivery vehicles. They intend to deliver flight test configurations of the electric propulsion systems within 2022.	Layout in sharing and other fields
June 2021	DENSO and NTT DATA announced that they had completed a joint verification test to improve mobility experiences using data on vehicle and people flows. In the test, they gathered participants' "vehicle flow data," or their movements by car, through in-vehicle devices and "people flow data" through their smartphone GPS and beacon detection logs. The test was conducted to provide better mobility experiences and services.	Connectivity layout, layout in sharing and other fields
July 2021	The first phase of DENSO's new automotive system plant in South China was officially completed and put into operation in Nansha. After the project is completed, the land area of the plant will increase to 150,000 square meters. The goal is to achieve a total output value of RMB10 billion by 2025.	Connectivity layout
July 2021	DENSO invested in Blaize, the AI computing innovator revolutionizing edge and automotive computing solutions. This will push Blaize into the field of electric vehicles.	Electrification layout
August 2021	The NS31A, a new RISC-V based 32-bit general purpose CPU that supports ISO 26262 ASIL D level functional safety for automotive applications, was introduced by NSITEXE, a spinout of DENSO. It is a general-purpose CPU for controlling various embedded systems including automotive applications.	Automation layout, electrification layout
February 2022	DENSO acquired a more than 10% stake in Japan Advanced Semiconductor Manufacturing, Inc. (JASM), TSMC's majority-owned manufacturing subsidiary in Kumamoto Prefecture, Japan.	Electrification layout
February 2022	DENSO announced that it will increase its annual inverter capacity to 10 million units by FY2025 (ending in March 2026), tripling the current level.	Electrification layout
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April 2022	DENSO and United Semiconductor Japan Co., Ltd. (USJC), a subsidiary of global semiconductor foundry United Microelectronics Corporation (UMC), announced that they had agreed to collaborate on the production of power semiconductors. The production is scheduled to start in the first half of 2023.	Electrification layout

Source: ResearchInChina

With the development of mobility technologies such as autonomous driving and electrification, the importance of semiconductors in the automotive industry is becoming more and more prominent. Recently, DENSO's semiconductor layout mainly pivots on digital chips with high computing power, which will be mainly used in AD systems/ADAS. In order to obtain more semiconductor-related resources, DENSO has successively formed close capital bonds with Renesas, Infineon, TSMC, and UMC.

At present, DENSO keeps an eye to meet the internal chip demand and support Toyota. If DENSO splits its semiconductor business in the future, the relationship with Toyota is expected to be loosened, facilitating its global expansion. After all, DENSO has become the world's fifth-largest supplier of automotive chips by sales volume, and digital semiconductors to mass-produced in 2023-2024 will be a blessing.

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