SANYO DENKI

Technical Report

Feature | Creating a New Era Together

1999
SANYO DENKI Techno Service CO., LTD.

60
November
2025

COLUMN

Cover image:

SANYO DENKI Techno Service CO., LTD.

1999

SANYO DENKI Techno Service Co., Ltd. was founded in 1999 as a wholly owned subsidiary of SANYO DENKI CO., LTD., starting its operations at Fujiyama Works, focusing on contract manufacturing. In 2000, it expanded into manufacturing, cleaning, and facility maintenance services, followed by logistics in 2001, and repair, measuring instrument calibration, circuit board design, and field services in 2002. The business further grew to include building maintenance in 2003 and recycling in 2004.

As part of its global expansion, the company established offices in Shenzhen, China in 2005, and in Singapore and Taiwan in 2006, strengthening its service network across Asia. These efforts have enabled the company to deliver prompt, reliable support to customers worldwide and earn their trust.

Since then, the company has continued to diversify, adding security, electrical works, vehicle maintenance, and solar power generation to its business domain. In 2013, it relocated its headquarters to the current Kangawa Works. Today, the company goes beyond repair and maintenance—providing preventive maintenance, system upgrades, and on-site technical support to help customers maximize equipment uptime. As a member of the SANYO DENKI Group, SANYO DENKI Techno Service delivers value-driven solutions that combine technical expertise with superior service, contributing to the sustainable development of society.

60 November 2025

SANYO DENKI TECHNICAL REPORT

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Creating a New Era Together

Satoru Onodera Operating Officer

The SANYO DENKI Group introduced a business company system in April 2024. The new system will consist of three business companies: San Ace Company, Electronics Company, and Motion Company. With this change, we have broken out of our old shell and taken the first step toward a new era. Guided by our corporate philosophy—"We at SANYO DENKI Group Companies aim to help all people achieve happiness, and work with people to make their dreams come true"—each business company leverages its specialized technologies and assets to provide products and services that contribute to people's happiness. In this issue, we will highlight the unique strengths and initiatives of each business company.

The Group has consistently pursued manufacturing that stays ahead of the times. Since the launch of our radio power generator in 1927, we have developed numerous industry-first products: hand generator (1951), Japan's first DC servo motor (1952), Japan's first stepping motor (1959), static power supply unit (1963), and Japan's first cooling fan (1965).

In the early 2020s, we continued to anticipate emerging needs with products such as the *San Ace Clean Air* air purifier, the *San Ace 80* Counter Rotating Fan featuring high static pressure and high airflow, optimized for GPU server cooling, the high-performance and energy-efficient *SANMOTION G* AC servo system, and the *SANUPS W83A* renewable energy inverter compatible with various renewable energy sources.

Our three product brands *San Ace*, *SANUPS*, and *SANMOTION* all represent energy conversion technologies. Our *San Ace* cooling fans convert electric energy to fluid energy. With *SANUPS* products, UPSs convert electrical energy into high-quality electrical energy. The *SANMOTION* products convert electrical energy into mechanical energy. The essence of these energy conversion devices lies in achieving higher efficiency, compact and lightweight design, and lower noise. We remain committed to continuously refining these qualities.

In the area of production technology, we have developed in-house expertise in mold design and manufacturing for resin molding, established production guidance systems, and promoted automation in parts processing and product assembly—all in pursuit of ever-higher productivity.

Our production guidance system enables anyone to assemble products precisely and efficiently by following on-screen digital work instructions. Work histories and inspection data are automatically recorded and analyzed to support continuous quality and process improvement. Developed more than 20 years ago, this system exemplifies our forward-looking approach to manufacturing.

Over the years, SANYO DENKI has built advanced capabilities in both product design and production. We specialize in fluid technology for creating smooth wind flow, technology for cleaning and controlling power, and servo technology for running and stopping motors as intended. We also specialize in customization, which we have developed together with customers over many years. To deliver optimal custom designs tailored to each customer, we need to gain a deep understanding of our customers. Delivering optimal custom solutions to our customers can be achieved by gaining a deep understanding of the issues faced by our customers, the problems they seek solutions to, and a clear image of “how they wish things to be.” We also specialize in production technology for efficiently producing high-quality products.

In this Technical Report, we introduce our core technologies and strengths that we have cultivated foreseeing the future. Through our business company system, we will keep advancing our core competencies while combining them with diverse technologies to create new value, new meaning, and new possibilities.

The SANYO DENKI Group will contribute to the health and safety of people, conservation of the global environment, and use of new, eco-efficient energy sources with *San Ace*, *SANUPS*, and *SANMOTION* products as well as our entire business activities.

San Ace Company — Technology and Strengths

Masashi Miyazawa　Yoichi Yamada　Daisuke Igarashi

1. Introduction

The San Ace Company has developed and released various cooling fans and related products over the years. As technology and customer needs have evolved, market demand has expanded from simple cooling applications to include suction, ventilation, and air circulation. Through these changes, we have developed a deep understanding of the challenges our customers face and the performance they require, enabling us to create products that deliver high performance, quality, and reliability.

In addition to new product development, we also excel at customizing products already in the market. By working closely with customers, we have continuously created added value and helped resolve technical issues in their manufacturing processes.

Our expertise in design, production, and quality control enables us to deliver products with advanced performance, assured quality, and high reliability.

In this issue, we will introduce technologies and strengths of each department.

2. Design Department — Technologies and Strengths

Our Design Department focuses on developing cooling fans that feature high airflow, high static pressure, low noise, low power consumption, and high reliability.

This section introduces the technologies that support the development of cooling fans and related products, the proprietary in-house equipment we have developed, and the added value we offer to customers.

2.1 Technologies and strengths in cooling fan development

2.1.1 Cooling fan design

We have built an automatic design system that combines fluid and motor simulations with optimization software, enabling quick and efficient development of advanced performance and highly reliable cooling fans.

This system can rapidly optimize various design parameters, helping shorten development lead times.

The impeller and frame shapes obtained through simulations are prototyped using the 3D printer in the Design Department. Their actual performance is measured and fed back into the simulation process, enabling continuous improvement in accuracy. Figure 1 shows a simulation of a cooling fan.

By leveraging optimized impeller and frame designs produced through this process—along with the expertise, accumulated know-how, and ideas of our designers—we continue to pursue higher cooling fan performance.

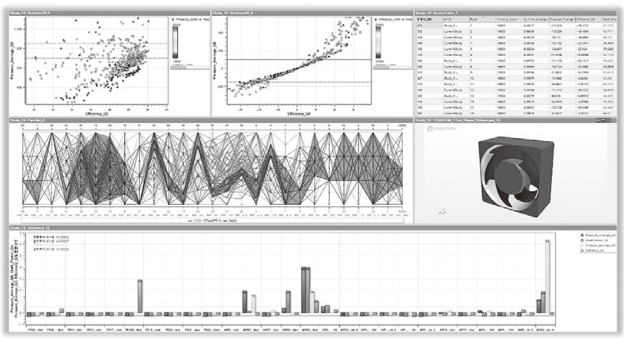

Fig. 1 Cooling fan simulation example

2.1.2 Cooling fan measurement equipment

We have built an environment that enables rapid inspection of many samples, from 3D-printed prototypes based on simulation results to molded components.

Our facilities include multiple double-chamber measuring devices for airflow vs. static pressure characteristics—fundamental indicators of cooling fan performance—as well as anechoic chambers for noise measurement. The data obtained from this equipment is used not only in product development but also to meet various customer requirements.

Figure 2 and 3 show a double chamber system and an anechoic chamber, respectively.

Fig. 2 Double chamber system
for airflow vs static pressure characteristics

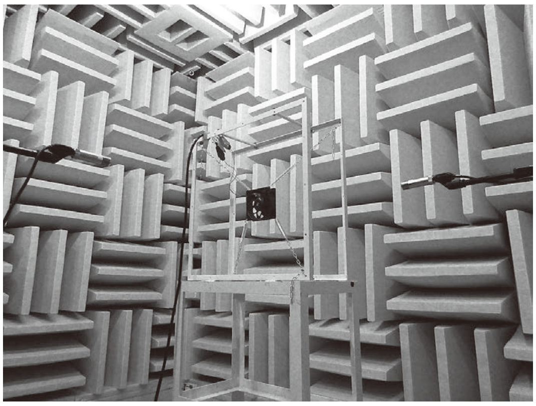

Fig. 3 Anechoic chamber

Air velocity distribution and noise under load are also important factors in evaluating cooling fans.

Our airflow velocity distribution system automatically measures airflow around the fan and visualizes the distribution.

The load noise measurement system captures noise levels automatically across nearly the entire airflow vs. static pressure operating range. Both systems were developed in-house, allowing us to support customer products with detailed evaluations conducted using our own equipment.

Figures 4 and 5 show the airflow velocity distribution system and the load noise measurement system.

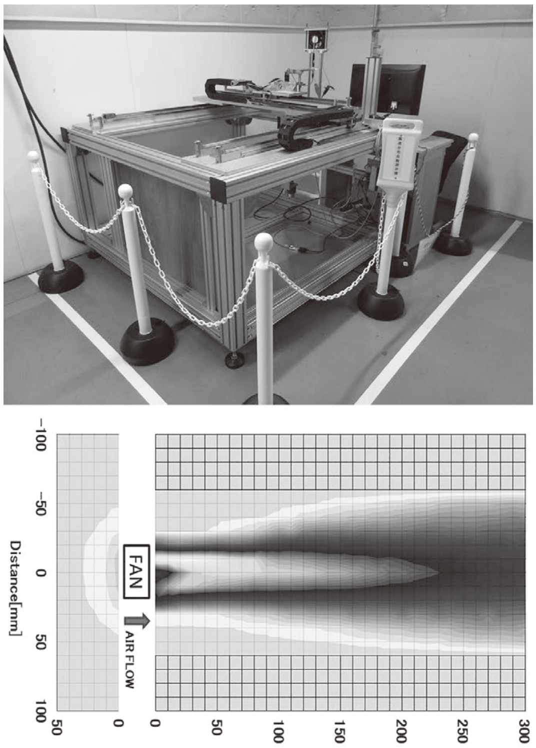

Fig. 4 Air velocity distribution system
with its distribution chart

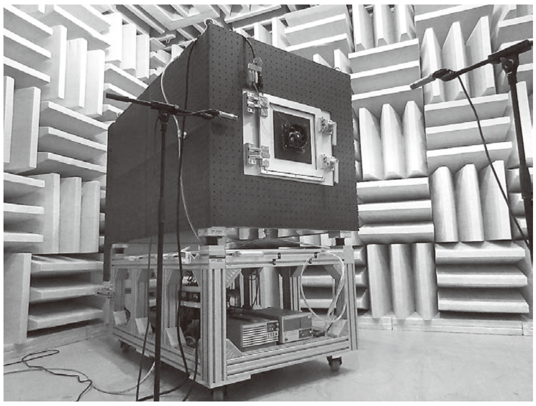

Fig. 5 Load noise measuring system

2.1.3 Impeller strength evaluation

As our customer products become more compact and advanced, demand for cooling fans capable of higher airflow or higher speed continues to rise. Ensuring impeller strength therefore remains essential to maintaining reliability. Because rotating impellers are difficult to observe directly, strength verification has traditionally relied on simulations.

To further improve impeller verification accuracy, we have introduced our proprietary impeller strength test system that evaluates impeller strength at various speeds and ambient temperatures. This increases the reliability of strength verifications and enables the development of cooling fans with even higher airflow performance.

Figure 6 shows the impeller strength test system.

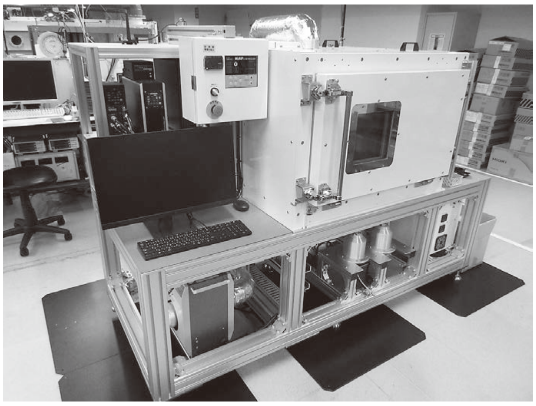

Fig. 6 Impeller strength test system

2.2 Development of fan-related products

We also actively develop fan-related products by leveraging the technologies and knowledge we have cultivated to date.

Examples include:

- a *PWM Controller* for easy fan-speed control,
- a portable *Airflow Tester* for airflow vs. static pressure measurements,
- the *San Ace Controller* for remote fan-speed control and cloud-based data storage, and
- the *San Ace Clean Air*, an air purifier for offices and other large spaces.

These products offer added value by allowing customers to use our fans more effectively and conveniently.

Figure 7 shows the cooling fan-related products.

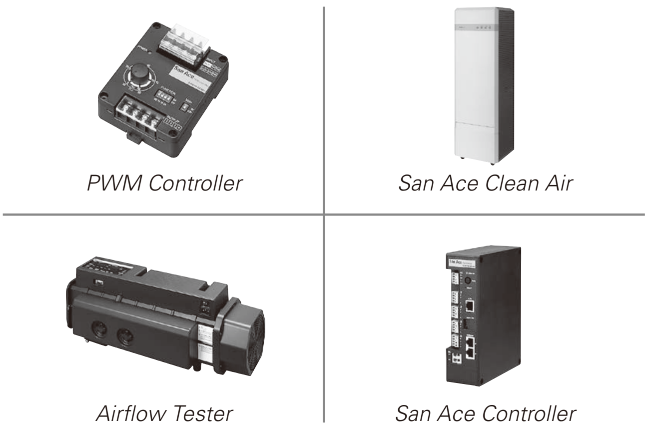

Fig. 7 Fan-related products

2.3 Cooling fan customization

We have a system that enables rapid, flexible response to a wide range of customization requests for cooling fans after their release to the market.

One example is a proprietary tool we developed to shorten lead times for additional wiring harnesses, which represent more than 80% of customization requests. This tool allows harness specifications to be finalized during sales meetings, significantly reducing the time needed for the Design Department to prepare drawings.

We have also released many fan units that integrate our cooling fans in response to customer requests both in Japan and overseas.

Figure 8 shows some examples of fan units.

Fig. 8 Example of fan units

2.4 Technical support for customer products

As part of our customization services, we offer technical support to help customers optimize the cooling performance of their products and integrate our fans effectively.

For many years, we have used our in-house measurement equipment to collect data under various conditions and to perform on-site measurements for customer products at our facilities.

More recently, we introduced a CFD Simulation Service, which applies our fluid-simulation technology to help customers resolve cooling challenges and select suitable fans.

3. Production Department — Technologies and Strengths

Our Production Department focuses on maximizing production efficiency through in-house technologies and production automation. This section outlines the advantages of our in-house mold manufacturing capabilities and how they are leveraged to production.

3.1 In-house mold manufacturing advantages

Figure 9 shows Production Department's integrated mold manufacturing system.

By unifying mold design, manufacturing, molding, and quality evaluation, we can fully utilize our mold technology to ensure rapid and accurate feedback during product development. This integrated system helps improve product competitiveness by ensuring that molded components precisely reflect development requirements.

Figure 10 shows an example of in-house molds manufacturing.

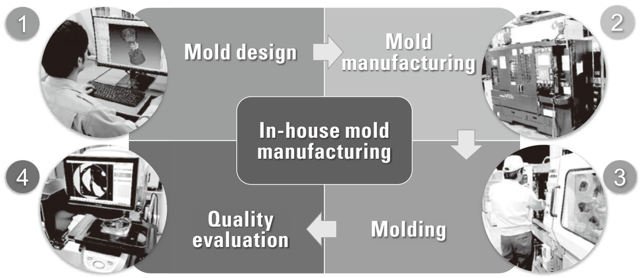

Fig. 9 Integrated production system of molds

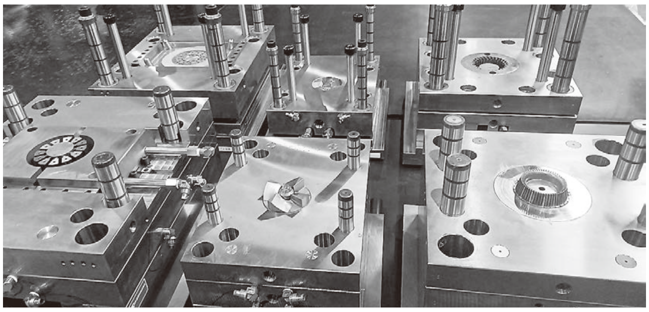

Fig. 10 Production example of in-house molding

3.2 Examples of in-house mold manufacturing technologies

This section introduces examples of how in-house mold technology is used to improve cooling fan performance, reliability, and production efficiency.

3.2.1 Mold manufacturing under optimal conditions

A key advantage of in-house mold manufacturing is the ability to design and build molds that are optimized for each component based on a detailed understanding of product specifications.

As cooling fans become more advanced, molded impellers must exhibit excellent balance at high speeds and greater structural strength. The Production Department evaluates multiple molding conditions to optimize component quality.

For example, a single-gate mold design allows resin to flow uniformly from the center of the impeller, improving balance and reducing the formation of weld lines, which are typically structural weak points.

Figure 11 shows a comparison of gate types.

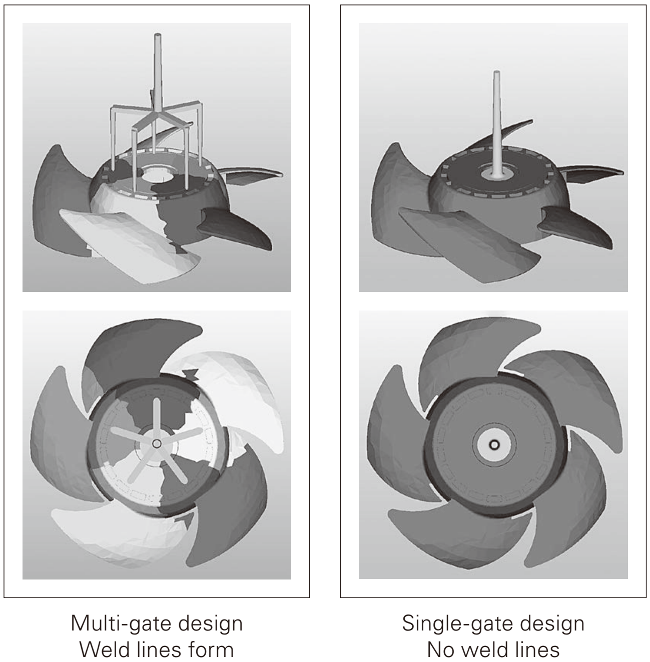

Fig. 11 Example of comparative analysis between gate types

3.2.2 In-mold automatic gate cutter technology

Figure 12 shows the gate-cutting process required for components molded with single-gate molds.

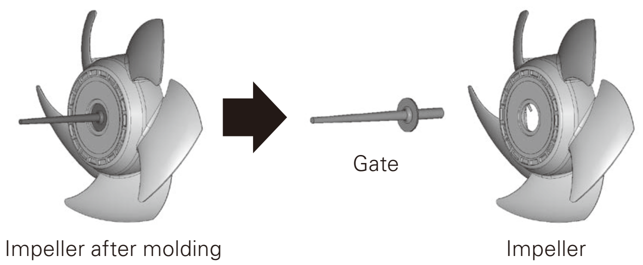

Fig. 12 Gate cutting

Although single-gate molds improve component balance, they also require manual removal of the gate after molding. To eliminate this manual step, the Production Department developed in-mold automatic gate cutting technology, which uses a hydraulic cylinder built directly into the mold. This mechanism cuts the gate during the molding process, enabling automated production.

Figure 13 shows the mold design with this integrated hydraulic cylinder.

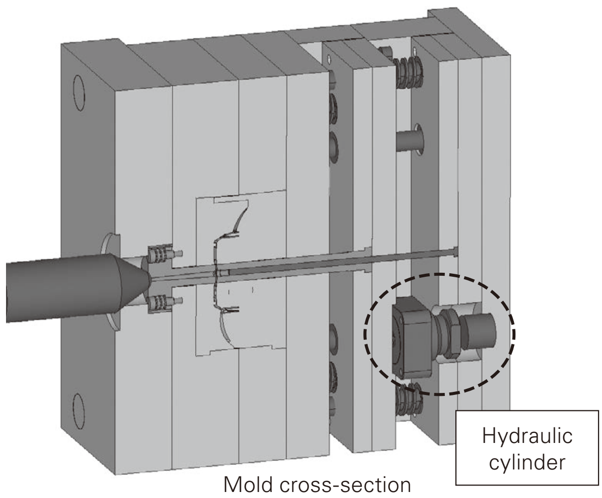

Fig. 13 Mold design integrating hydraulic cylinder

Using this technology improves impeller quality by enhancing balance performance, reducing vibration, increasing strength, and eliminating weld lines—while also removing the need for manual gate cutting.

3.3 Expansion into external mold sales

Since introducing in-house injection mold production in 2000, the Production Department has designed, manufactured, and molded more than 600 tools. Leveraging our high-precision machining capabilities and integrated production system, we now offer external mold manufacturing services, enabling the rapid delivery of high-quality injection molds to customers.

4. Quality Control Department — Technologies and Strengths

Our Quality Control Department is engaged in ensuring high quality. This section introduces our automation technology for acoustic and vibration inspection—areas that have traditionally been difficult to automate.

4.1 Product inspection

Cooling fan inspection includes checks for noise and vibration.

We perform several inspections, including:

- Acoustic inspection to verify that no abnormal noise occurs during operation
- Vibration inspection to check for unusual vibration
- Waveform inspection to confirm that motor current and sensor output show no anomalies
- Visual inspection to check frames and impellers for damage or defects

Acoustic inspection relies on hearing, vibration inspection on touch, and waveform and visual inspection on sight. For this reason, only inspectors who have completed internal certification programs are permitted to conduct these evaluations.

4.2 Technologies for addressing inspection challenges

Acoustic and vibration inspections are essential, yet accuracy can vary when tests rely on human perception. This variation arises because:

- Perception differs among individuals
- Daily changes in a worker’s physical condition affect sensory accuracy

To overcome these issues, we introduced automated inspection systems to shift from subjective evaluations to highly reliable quantitative measurements.

Figure 14 shows our inspection equipment.

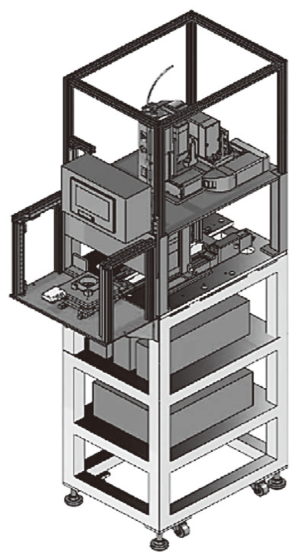

Fig. 14 Inspection equipment

4.2.1 Vibration inspection

Vibration inspection typically uses either contact or non-contact vibrometers.

Contact vibrometers require attaching a sensor to the fan. This adds mass to the fan, making it unsuitable for automation—especially when measuring small, lightweight models where accuracy is affected.

Non-contact vibrometers avoid this problem and allow measurements without influencing vibration levels. Based on this advantage, we adopted a laser vibrometer as the core device for our automated vibration inspection system.

Figure 15 shows vibration inspection equipment.

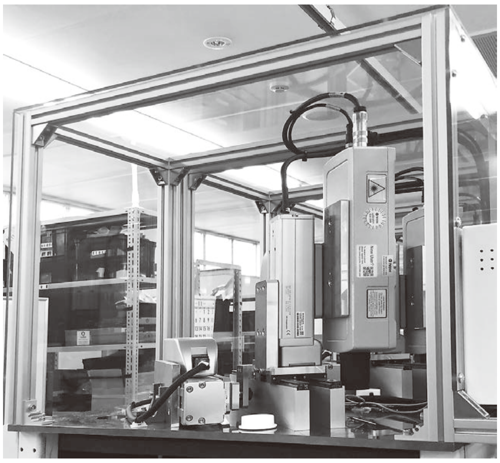

Fig. 15 Vibration inspection equipment

4.2.2 Acoustic inspection

We transitioned from human-based hearing to automated acoustic inspection using microphones.

Abnormal noise typically arises from bearing issues such as brinelling, contact between components, or foreign matter. Each of these noise types presents distinct frequency characteristics, which must be accurately identified during acoustic inspection.

However, because frequency and peak amplitude vary by fan model, defining consistent criteria across models was challenging.

To resolve this, we used the Mahalanobis-Taguchi (MT) method[1], an AI-enhanced technique.

Using the MT method, data from normal products are first collected within a decision space. The distance between the new measurement data and this decision space is then calculated. This distance determines whether the sound is normal or abnormal. Figure 16 illustrates the MT-method concept.

Applying the MT method to our acoustic inspection allows us to create a decision space using frequency-analysis data. This enables precise detection of abnormal noise with different tonal characteristics, supporting full automation of the inspection process.

Figure 17 shows the automated acoustic inspection equipment.

These automated systems have clarified trends and root causes of abnormal noise and vibration in manufacturing, contributing to more efficient assembly processes, optimized component management, and refined product design.

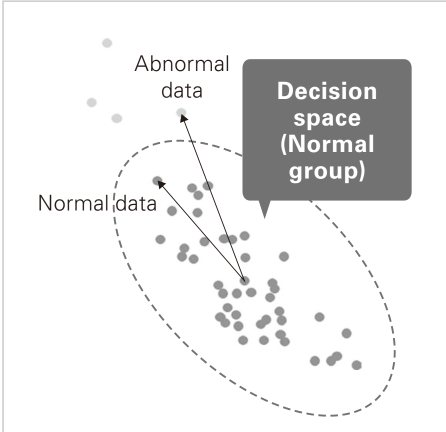

Fig. 16 Concept of the MT method

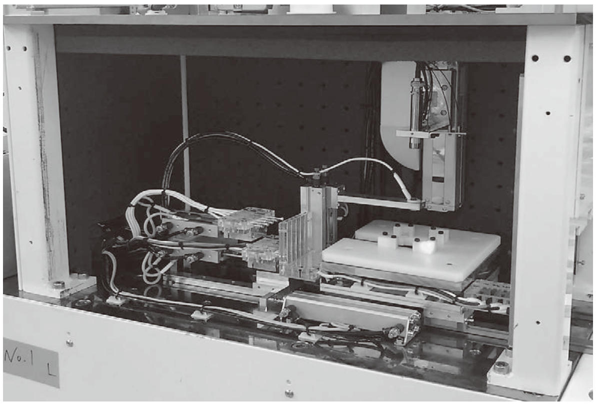

Fig. 17 Acoustic inspection equipment

5. Conclusion

This article has presented our technologies and strengths across the three departments: Design, Production, and Quality Control.

To enhance product performance during development, we employ simulation technology and proprietary measurement equipment to achieve high-precision product designs.

For manufacturing molds, which transform designs into products, we have established an integrated system for design, manufacturing, molding, and quality evaluation, enabling rapid production of high-quality products.

With our system, even slight abnormalities in finished cooling fans can be reliably detected. By incorporating advanced inspection methods and AI technology, we deliver highly reliable products with assured quality.

We will continue addressing customer challenges by leveraging our proprietary technologies in product development, thereby creating new value.

Reference

(1) Masato Suzuki, Introduction to the MT System Analysis Method: Mastering Quality Engineering Through Experimentation
Note: The book title is an unofficial English translation provided only for reference.

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Electronics Company —Technology and Strengths

Hideaki Kodama Masayuki Shibata Satoru Tsuchiya Kenichi Fujisawa Masao Mizuguchi

1. Introduction

Electronics Company develops and manufactures two product brands: SANUPS and SANMOTION. Although these brands cover different products, both are based on energy conversion technologies. SANUPS products, such as, uninterruptible power supplies (UPSs) and renewable energy inverters, convert electrical energy into higher-quality electrical energy. SANMOTION servo system products convert electrical energy into mechanical energy. SANMOTION consists of motors and control units, and Electronics Company is responsible for developing and manufacturing the control units, including servo amplifiers and controllers.

We have three core technologies: energy conversion, production, and customization. Building on these strengths, we carry out five team activities to create new value.

This article introduces both our three core technologies and the five team activities. First, we explain our areas of core technologies and team activities, and then we present specific examples of the team activities.

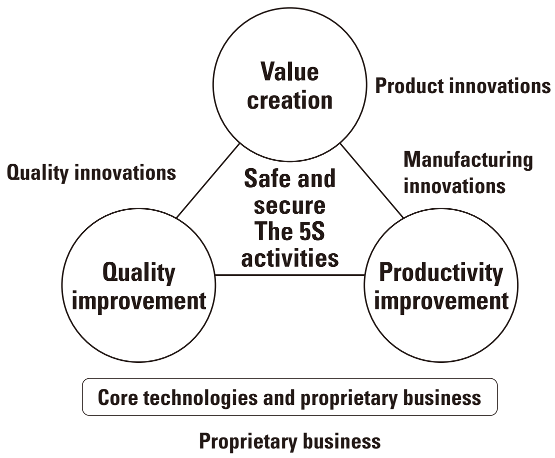
2. Core Technologies and Five Team Activities

We are committed to create products that customers can use with confidence. We commit to creating value for customers and society (value creation), ensuring quality that enables safe and reliable use (quality improvement), and manufacturing products efficiently (productivity improvement)—the three pillars that represent the essence of manufacturing.

All of these are supported by a safe, secure, and fulfilling workplace. At the Electronics Company, each employee keeps the customers in mind and leverages their strengths to develop products while working as one team to create a fulfilling workplace.

We have also cultivated our core technologies to date, which sourced to create our proprietary businesses.

As shown in Figure 1, we carry out five team activities: value creation, quality improvement, productivity improvement, safe and secure workplaces, and proprietary business development. All of our employees participate in these team activities through "all-hands engagement."



Five team activities

1. Product Innovation: Create value through products and technology
2. Quality Innovation: Ensure safe and reliable product quality
3. Manufacturing Innovation: Maximize value while minimizing production cost
4. 5S Activities: Create a safe, secure, and fulfilling workplace and develop human resources
5. Proprietary Business: Develop unique businesses leveraging our core technologies

Fig. 1 Five team activities

The Product Innovation Team creates value for customers and society through our products and services. The Quality Innovation Team enhances the quality of our products and services to ensure safe and reliable use. The Manufacturing Innovation Team improves production efficiency, pursuing manufacturing that delivers maximum value at minimal cost.

The 5S (Sort, Set in Order, Shine, Standardize, and Sustain) Workplace Organization Team works to create a safe, secure, and fulfilling workplace. This workplace development is positioned as the foundation not only for value creation, quality enhancement, and manufacturing capability, but also for human resource development.

Lastly, the Proprietary Business Team applies our core technologies to develop unique businesses within the Electronics Company, contributing to solving customer challenges.

At SANYO DENKI, we have built extensive expertise in product design and production through years of experience. We specialize in power conversion technology that cleanly converts and controls power, and servo technology that starts and stops motors as intended—both of which involve converting energy. We also excel in production technology that enables efficient production of high-quality products, as well as in customization technology developed over many years in collaboration with our customers. This customization technology enables optimal, tailor-made designs for each customer. These three areas—energy conversion, production, and customization—are our core technological strengths. By combining these core technologies with the activities of our five teams, we deliver products and services that create value for our customers and society.

3. Product Innovation Team

Both *SANUPS* and *SANMOTION* products are energy conversion devices, whose essential qualities are compact size, light weight, high efficiency, and low noise. We work to deepen each brand's expertise and develop new products and services centered on energy conversion.

First, we introduce products that leverage our energy conversion expertise. Next, we highlight our efforts to deepen this expertise and create new value.

3.1 Energy conversion devices by brands

3.1.1 *SANUPS* products

Figure 2 shows the *SANUPS W83A* renewable energy inverter. A single unit of this product supports a wide range of renewable energy sources. By optimizing power control to match each customer's generation system, it maximizes the use of renewable energy and boosts energy conversion efficiency by 2% over our current products.

Fig. 2 The *SANUPS W83A* renewable energy inverter

Figure 3 shows the *SANUPS A13A*. This product uses a modular UPS system, enabling parallel configurations of up to four modules. Even if one UPS module stops operating, the remaining modules continue to supply power, demonstrating the high reliability of the product. In addition, the use of a next-generation power conversion device and optimized control has improved the energy conversion efficiency by 8% over our current products.

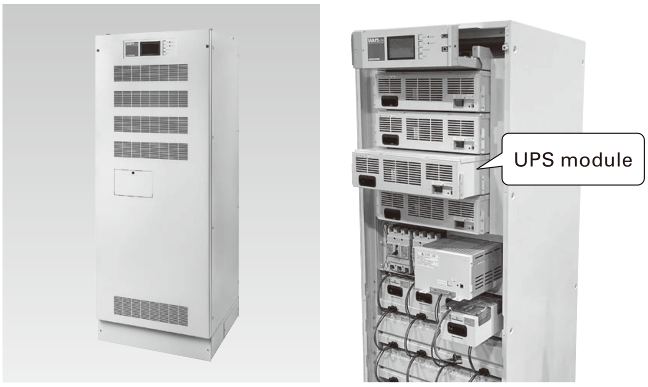


Fig. 3 The *SANUPS A13A*

3.1.2 *SANMOTION* products

Figure 4 shows the *SANMOTION G* 48 VDC servo amplifier. This servo amplifier operates on 48 VDC, which is increasingly demanding in applications such as semiconductor manufacturing equipment and battery-powered applications. With a low-loss design and enhanced heat dissipation, the product reduces energy loss by 12.8% over our current products.

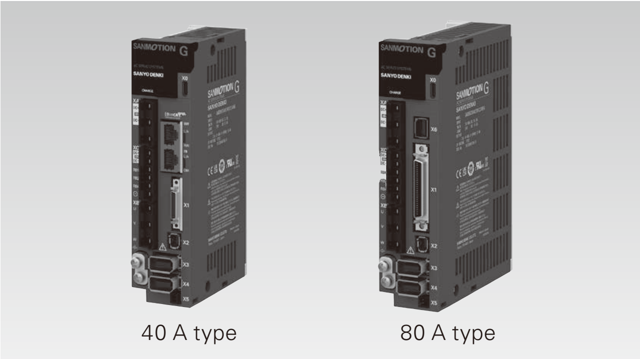


Fig. 4 The *SANMOTION G* 48 VDC Servo Amplifier

Figure 5 shows the *SANMOTION G* 2-axis integrated AC servo amplifier. This product offers a compact, lightweight design and contributes to energy savings. Compared to using two single-axis servo amplifiers, it reduces the installation footprint by 38% and the weight by 19%, achieving a significant reduction in size and weight. By efficiently utilizing regenerative energy across both axes, it also cuts energy loss by 18%.

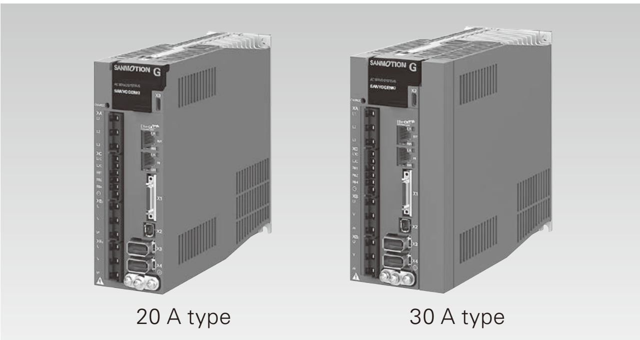


Fig. 5 The *SANMOTION G* 2-Axis Integrated AC Servo Amplifier

3.2 Team activities with core technologies

Our strength lies in our core technologies that enable compact, lightweight, efficient, and low-noise products, which are applied to both *SANUPS* and *SANMOTION* products.

With the Co-Creation Matrix shown in Table 1, the Product Innovations Team is working to further enhance the core technologies behind *SANUPS* and *SANMOTION* products, creating new value.

Table 1 Co-Creation Matrix

Electronics Company		***SANUPS*** Technology, product, service	***SANUPS*** Factory, Equipment, Markets, Customer
SANMOTION	Technology, product, service	**Combine core technologies Strengthen shared expertise**	**Offer *SANMOTION* products** to *SANUPS* market
SANMOTION	Factory, Equipment, Markets, Customer	**Offer SANUPS products** to *SANMOTION* market	To new customer/ market **Innovate new technology Develop co-created products**

3.2.1 Deepen core technologies

(1) Compact, lightweight, high-efficiency, low-noise

The technologies that enable compact, lightweight, high-efficiency, and low-noise products are the essence of energy conversion devices. They deliver technological, economic, and environmental benefits, such as reduced size and power consumption for both customer equipment and our products. This is the core capability we continue to pursue. For example, we have developed an optimized control for gallium nitride (GaN) and silicon carbide (SiC) devices—the latest power conversion devices—to produce more compact, lightweight, higher-efficiency, and lower-noise products.

(2) High-response motion control with disturbance rejection

For *SANMOTION* products, we are developing high-speed control technologies to achieve higher-response control resistant to disturbances. This technology helps reduce cycle times, improve accuracy, and stabilize the power supply for customer equipment.

(3) Eco-friendly production

To reduce power consumption in the component mounting process of PCB boards used in both product lines, we are developing a technology that enables mounting with low-melt solder. This approach reduces environmental impact during production while maintaining the high-quality of PCB boards.

3.2.2 Value creation

(1) Product failure prevention

For *SANUPS* products, we are developing a technology that monitors temperature and humidity in the installation environment and uses the data via the cloud for predictive maintenance and failure diagnosis. By monitoring the operating environment and detecting early signs of failure, maintenance can be performed appropriately based on the deterioration levels and service life predictions.

(2) Control technology using external sensors

For *SANMOTION* products, we are pursuing more advanced, precise motor control by using data from accelerometers, force sensors, and pressure sensors alongside existing position and speed feedback control. Through these efforts, we aim to achieve smooth, high-precision motion and enhanced stability in customer equipment.

(3) Co-Creation products

Servo systems face issues such as high energy consumption during acceleration and heat generation due to regenerative energy resistance during deceleration. To solve these issues, we are developing energy-saving products that combine the core technologies of the *SANUPS* and *SANMOTION* brands. This is one of our initiatives for improving energy efficiency across servo systems.

4. Quality Innovation Team

We leverage our core technologies to improve product quality and ensure safe, reliable use for our customers.

This chapter presents our efforts to use production guidance systems and to prevent failures through automated testing.

4.1 Production guidance system

We employ production guidance systems in our manufacturing processes. As shown in Figure 6, the system displays digitized work procedures on a PC screen or LEDs to accurately guide operators through their tasks. This system has improved manufacturing quality by enabling consistent performance, regardless of workers' skill.

Fig. 6 Production guidance system

4.2 Initiatives to prevent defects

We have established an automatic evaluation system that automates test condition setting, measurement, and judgment processes, eliminating accidental omissions. By automatically performing evaluation tests that comprehensively cover customer operating conditions, product quality is significantly improved.

Figure 7 shows an automatic measurement system for temperature-rise tests on *SANUPS* renewable energy inverters. A PC automatically sets test conditions, collects measurement data, and determines pass/fail results.

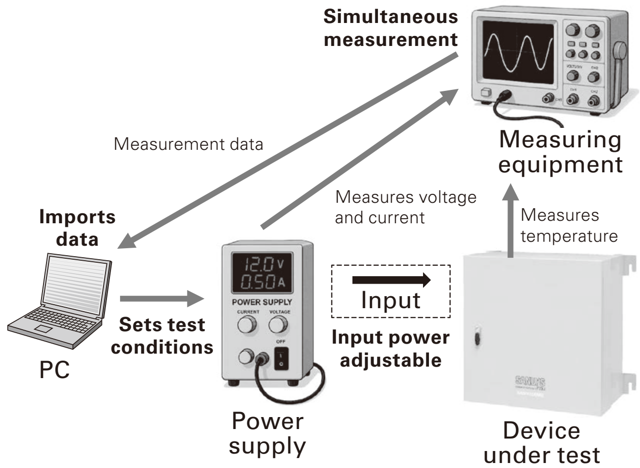


Fig. 7 Auto evaluation system

Design or component changes are a common source of defects. We address these changes early in the design phase to prevent defects before they occur.

5. Manufacturing Innovation Team

In addition to equipment automation and production guidance systems, we implement four key activities to improve productivity: awareness initiatives, digital technology utilization, co-creation, and human resource development. These activities enhance productivity while also increasing employee motivation.

5.1 Awareness initiative

During daily production operations, workers often encounter moments when something feels off or prompts them to question the cause. Our awareness initiative allows workers to record any irregularities or concerns on an Awareness Card, enabling issues to be shared and used as a basis for improvements at the production site.

Figure 8 illustrates the workflow of the digital Awareness Card system. Entries are automatically uploaded to a shared cloud-based Excel file, allowing relevant personnel to monitor improvement progress in real time. We have also built a system that uses the *SanBI* business intelligence tool to automatically compile and analyze the stored data to visualize the improvement status by workplace and process, supporting tracking of the PDCA cycle.

Through this initiative, we have successfully shortened the time required to identify and improve problems at production sites. This encourages proactive employee development, further improving productivity and strengthening problem-solving capabilities.

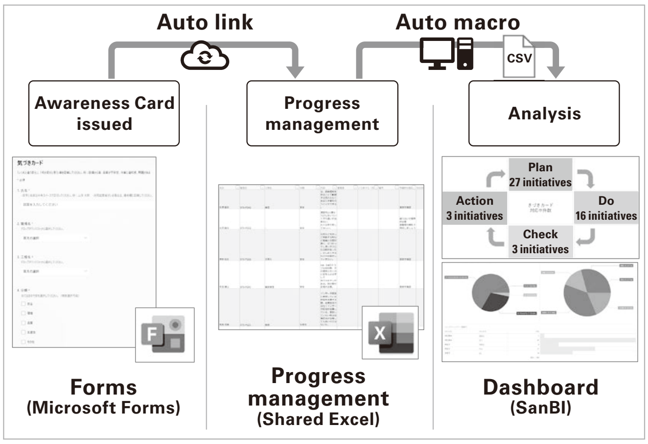


Fig. 8 Workflow of the digital Awareness Card

5.2 Use of digital technology

At production sites, factors that affect productivity and quality change on a daily basis, making continuous issue identification and improvement essential. Leveraging digital technology, we visualize productivity, quality, and electricity usage data using the *SanBI* business intelligence tool, while automating administrative and routine tasks with robotic process automation (RPA).

5.2.1 Visualization of productivity, equipment, and quality data

Production results and progress, equipment operating rates, quality data, and error information are automatically collected from PLCs, various sensors (current, voltage, and temperature), and related systems. *SanBI* is used to visualize overall production-site conditions. As shown in Figure 9, the accumulated data is displayed in graphs and dashboards, providing an instant view of operating conditions and production progress. This enables analysis of productivity and quality trends and allows for early detection of equipment abnormalities, helping workers and managers quickly understand site conditions and make timely decisions and improvements.

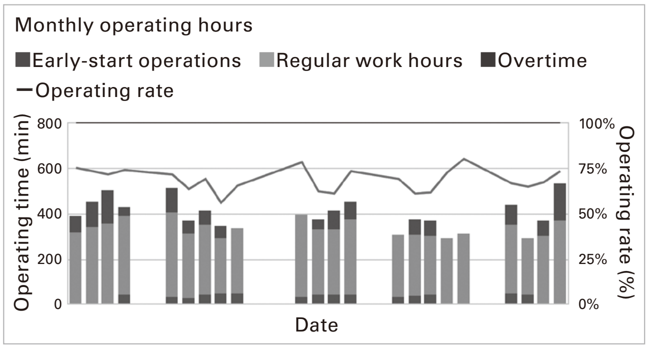


Fig. 9 Visualization of operating rate

5.2.2 Visualization of electricity usage

As shown in Figure 10, we have successfully used *SanBI* to visualize electricity usage for each building at our Fujiyama Works.

In the past, data obtained from the electricity monitoring equipment had to be manually edited, but we have now built a system that automatically collects, converts, and uploads the electricity data to *SanBI*. This allows us to detect abnormal electricity usage at an early stage and take prompt action to optimize electricity usage. Going forward, we plan to visualize electricity usage in greater detail, such as by floor and by distribution board, to further optimize energy consumption across the entire complex.

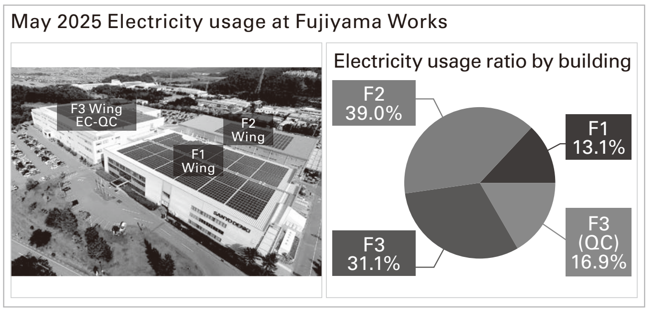


Fig. 10 Visualization of electricity usage at Fujiyama Works

5.2.3 Use of Robotic Process Automation (RPA)

As illustrated in Figure 11, RPA records routine PC-based tasks performed by workers as RPA software project files, allowing robots to execute those tasks automatically. This reduces labor hours and prevents human error.

We have introduced RPA to various preparation tasks in our production processes, cutting working hours by up to 50%. Going forward, we plan to reinvest the time saved through automation into higher-value-added tasks and new value creation.

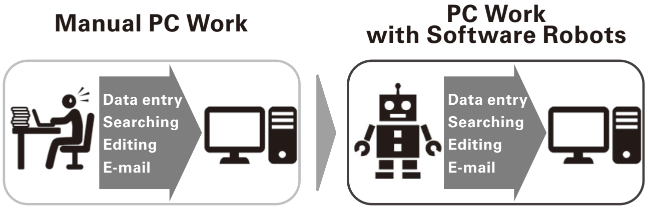


Fig. 11 Use of RPA

5.3 Co-creation

As a co-creation initiative between *SANUPS* and *SANMOTION*, we have integrated the board production processes of the two brands to improve production efficiency and make more effective use of the equipment and factory space.

By sharing and leveraging automation equipment and a production guidance system, one of our core technologies, we have established a highly efficient production framework. In addition, we are promoting flexible work styles to make the most of the diverse skill sets of our production staff, helping to boost motivation and support employee development.

We are also actively working with partner companies on co-creation activities centered on our core technologies. By combining the core technologies of the Electronics Company with those of our partners, we are driving value creation for both parties through initiatives such as new product and service development and productivity improvements.

5.4 Human resource development

To further improve productivity and high-quality manufacturing, the Electronics Company is strengthening employee skills with the aim of developing the world's best soldering technicians.

Meeting international soldering standards requires broad knowledge and advanced skills. To cultivate the required expertise, we are developing a proprietary training system to promote efficient human resource development. This system visualizes learning progress, analyzes proficiency, and provides individualized learning plans, enabling us to systematically train world-class soldering technicians.

For *SANUPS* products, many processes—such as the manufacturing and inspection of engine generators—require the advanced techniques and skills of highly experienced workers. By utilizing this new training system in these areas, we can ensure effective transfer of skills and strengthen the training of personnel involved in product manufacturing and inspection.

6. 5S Workplace Organization Team

The 5S activities (Sort, Set in Order, Shine, Standardize, and Sustain) form the foundation of manufacturing and are directly tied to safety, productivity, and quality. We are working to create a safe, secure, and fulfilling workplace and nurture our employees, while continuously advancing the 5S activities. Table 2 lists the major initiatives.

Table 2 Workplace improvement and employee development

Category	Initiatives	Effect
Workplace Improvement	5S inspection	Maintain and sustain workplace organization Reduce safety and quality risks
	Sorting	Identify and remove unnecessary items
	Labeling and placement	Standardize item locations and quantities
	Cleaning	Detect equipment abnormalities early Improve workplace environment and safety
Employee Development	Company-wide 5S training New employee training	Foster autonomy and engagement Increase motivation Support employee development
	5S manual training	
	Team reports	
	5S recognition	

(1) Workplace improvement

We carry out workplace improvement activities—including 5S inspection, item sorting, clear placement and labeling, and regular cleaning—to improve the work environment, enhance safety, ensure quality, and enable early detection of equipment abnormalities.

(2) Employee development

Through company-wide 5S training, 5S manual training, and team reporting activities, we foster employee autonomy and engagement while supporting individual growth and skill development.

7. Proprietary Business Team

The Proprietary Business Team develops new businesses by leveraging the Electronics Company's core strength—customization technology.

As part of these efforts, their production engineering services apply customized design and manufacturing technologies—including robot integration and automation—

to help customers address challenges in their production operations.

7.1 Production engineering services

(1) Production guidance system

We employ production guidance systems in our manufacturing processes as presented in Section 4.1.

Since its development 20 years ago, the system has been used across a wide range of products—from compact devices to large control panels. Its strengths lie in its flexibility and high degree of customization. The system continues to evolve through the integration of digital technologies.

In recent years, growing needs related to labor shortages, high-mix/low-volume production, and the digitalization of manufacturing have led to an increase in inquiries about adopting this system from companies facing similar challenges. In response, we have been providing customized versions of the system for each customer.

We will continue to support improvements in productivity and quality by solving our customers' manufacturing challenges and delivering user-friendly products tailored to their needs, while creating new value together with our customers.

(2) Example of a cardboard palletizing system

This subsection presents an example of a customized cardboard palletizing system incorporating *SANMOTION* products.

Figure 12 shows the cardboard palletizing system. The system automatically stacks cardboard boxes containing products onto pallets.

Fig. 12 Cardboard palletizing system

To develop this system, we used robotic technology and structured the implementation process into phases, as shown in Table 3, to ensure stable operation of the conveyor and the robot. By clarifying each work phase and its tasks, anticipating potential issues in each phase, and preventing omissions in the workflow, we have successfully shortened the development lead time and stabilized equipment operation.

Table 3 Implementation of the cardboard palletizing system

Phase	Description
(1) Site survey, requirement definition	• Survey workspace, line layout, and operations • Identify box types, sizes, weights, and daily throughput
(2) System/ Specification design	• Determine stacking patterns, robot type, and payload • Verify communication with PLCs, conveyors, and pallet feeders
(3) Design, fabrication, in-house testing	• Configure servo amplifiers and design motion sequences • Verify robot operation using 3D simulation
(4) Installation, on-site adjustment	• Schedule installation and perform site tests • Verify operation with actual boxes
(5) Operation check, trial run	• Share information with operators and maintenance staff • Fine-tune performance and confirm stable operation
(6) Full operation, evaluation, and improvement	• Start full-scale production and address initial issues • Collect operating data and implement improvements

7.2 Automation and labor-saving technologies

The cardboard palletizing system was built by customizing our *SANMOTION C S500* Motion Controller. We automated the process by enabling control of the robot arm, conveyor, and image recognition equipment, improving work efficiency and reducing labor requirements.

Figure 13 shows an image of the teaching procedure for the palletizing robot. The controller program has been customized to flexibly accommodate variations in box size, weight, and stacking patterns simply by teaching the positional relationship between the robot hand and pallet.

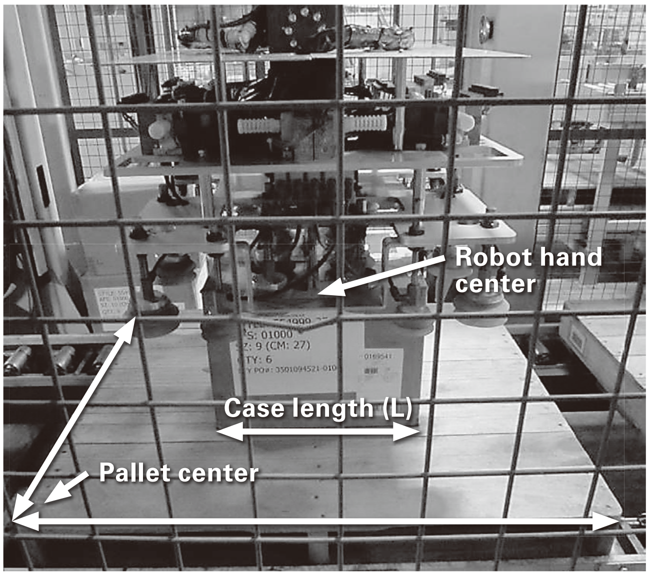


Fig. 13 Teaching procedure for the palletizing robot

8. Conclusion

This article has presented three core technologies and five team activities of the Electronics Company.

Our three core technologies are:

(1) Energy conversion technology (compact, lightweight, highly efficient, and low-noise)

(2) Production technology (enabling proper and efficient use by anyone)

(3) Customization technology (customer-oriented optimized design)

We excel in manufacturing energy conversion devices that are compact, lightweight, highly efficient, and low-noise. We are also highly skilled in providing optimized custom designs tailored to each customer.

These three core technologies are rooted in our five team activities. Through our team activities, we will continue to further improve product and service quality, strengthen productivity, and combine our core technologies with complementary capabilities to create new value for customers and society.

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Motion Company ― Technology and Strengths

Kazuhiro Makiuchi　Shusaku Magotake

1. Introduction

The Motion Company develops, manufactures, and sells servo motors, delivering products to customers worldwide. We excel at customizing products to meet specific customer equipment requirements by leveraging our long-cultivated strengths in motor design and production technology.

The purpose of customization is to enhance equipment performance and strengthen market competitiveness. Customization examples include modifying motor windings to optimize characteristics for the customer unit, adjusting connectors and cover shapes to fit components into limited spaces, and designing output shafts and mounting flanges for smooth equipment integration. When customizing, we collaborate with customers from the planning stage to define motor specifications, enabling us, as servo motor professionals, to engage closely in their development efforts.

Meanwhile, the wide range of customization options requires our factories to handle high-mix, low-volume production. Although such production generally reduces productivity due to increased setup time, our advanced production technology has overcome these challenges. By strategically allocating workers and automated equipment, we have minimized setup time and cycle time while maintaining high-quality production lines supported by our production guidance system.

This article presents examples of customer-specific customization and innovative approaches to improving production efficiency. It also introduces the production engineering services launched in 2024, showcasing the new value we provide.

2. Customization Tailored to Customer Equipment

Customization requirements vary significantly depending on customer equipment. This chapter presents three examples of customization designed for different applications.

2.1 Customization for semiconductor manufacturing equipment

A standard motor is usually supplied as a unit with the rotor and stator enclosed in a housing (flange, frame, or bracket). However, integrating the housing into the customer's equipment can reduce overall size without compromising motor performance. In this case, we provide the rotor and stator separately, as shown in Figure 1, for installation into the customer's equipment. These products are called built-in motors.

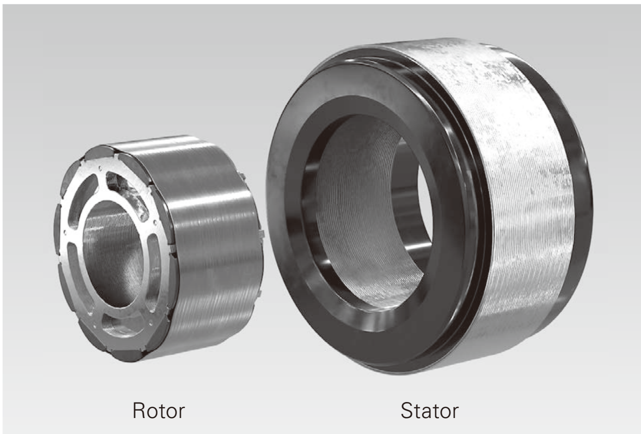


Fig. 1 Built-in motor

Figure 2 shows a wafer conveyor robot for semiconductor manufacturing equipment. These robots use a single-core, multi-axis structure with two or more output shafts on a single axis, and our built-in motors are used for these robots.

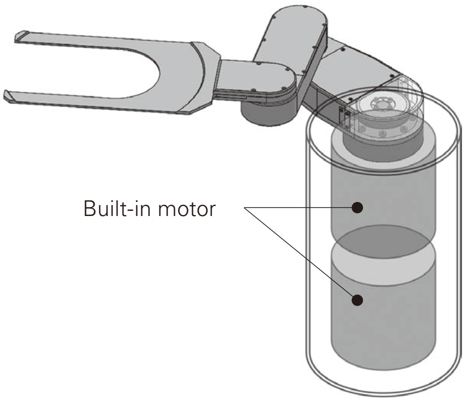


Fig. 2 Wafer conveyor robot

The motors for wafer conveyor robots do not require high maximum speeds but must deliver high torque at low speeds. Furthermore, because these motors operate under special conditions, including vacuum and high-temperature environments, they must be constructed with specialized materials. Customized built-in motors are suitable for reducing equipment size while satisfying these demanding specifications. During design, either the inner or outer rotor type is selected based on the structure of the customer's equipment. Materials are then chosen according to the operating environment. Furthermore, the core shape and winding specifications are determined to achieve the required torque characteristics. We use 3D models to design the motor structure, ensuring minimal space usage and preventing interference with customer equipment.

Table 1 lists typical built-in motor specifications. A base design with dimensions closest to the customer's requirements is selected, and the optimized windings minimize cost and lead times.

2.2 Spindle motor customization

One of our core product areas is spindle motors used in machine tools. Figure 3 shows a spindle motor. Spindle motors generally operate at high speeds, requiring specialized winding configurations and rotor designs. For machine tool spindles, we manufacture motors with maximum speeds ranging from 10,000 min^{-1} to 27,000 min^{-1}. The balance between the maximum speed and torque can be adjusted to meet customer specifications. To increase the maximum speed of a servo motor, for example, customization may include modifying the winding specifications or magnet arrangement. Servo amplifiers can be adjusted by changing the current-control parameters in the high-speed range. In some cases, modifications to the customer's controller may also be included.

A key strength of our approach is the ability to optimize the entire servo system including the motor, servo amplifier, and the customer's controller enabling us to propose and implement optimal customization.

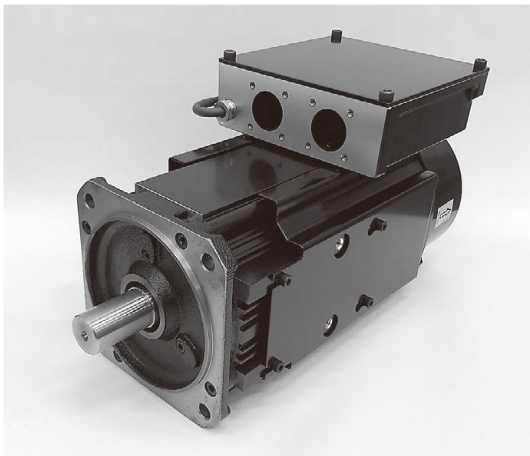
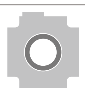
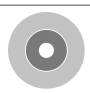


Fig. 3 Spindle motor

Table 1 Typical built-in motor specifications

Shape	Stator size			Rotor size		
	Dimensions [mm]	Inner diameter [mm]	Length [mm]	Dimensions [mm]	Inner diameter [mm]	Length [mm]
	40 × 40	ø24	23.5	ø23	ø16	9
	60 × 60	ø33	27.5	ø32	ø22	12
	ø80	ø50	71	ø49	ø22	63
	ø123	ø72	44	ø71	ø35	37

2.3 Energy savings through high-efficiency motors

We have achieved significant energy savings for customer equipment by replacing the induction motor previously used on a given axis with a synchronous motor. This customization is based on our *SANMOTION R* series motor, our standard product (Figure 4).

The newly designed rotor in this customization reduced resource and energy consumption in the customer's equipment while enhancing the efficiency of the development process.

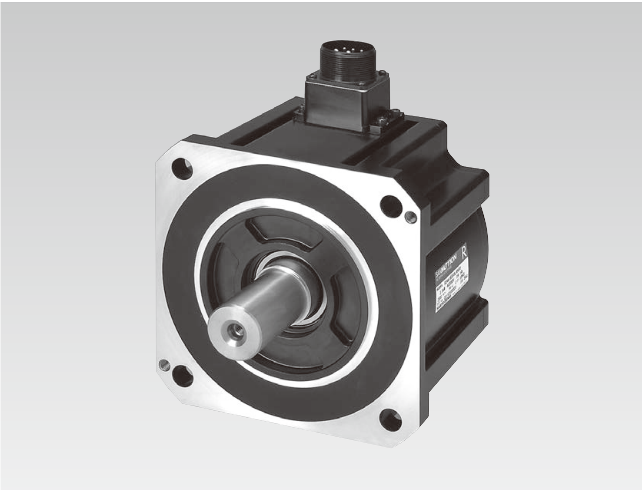


Fig. 4 SANMOTION R series motor as a customization basis (180 mm sq. size)

2.3.1 Motor resource efficiency

An embedded-magnet synchronous motor was used to reduce permanent magnet usage by 20% compared to an existing servo motor of the same output. The motor's outer diameter and volume were reduced by 40% and 60%, respectively, compared to the existing induction motor. By significantly reducing rare-earth content and structural components, the customer's equipment became more resource-efficient.

2.3.2 High-efficiency motors

Motor design incorporated inductance to reduce switching harmonics in the current, improving efficiency by 14% over the existing induction motor. This directly reduced the energy consumption of the customer's equipment.

2.3.3 Development optimization

Despite being a synchronous motor, the motor can be controlled without a position sensor by detecting changes in inductance, just like an induction motor. This has enabled the current inverter to be used as is. By using our standardized stator components, we minimized initial costs and development time. Leveraging existing assets improved our customers' development efficiency.

3. Production Equipment Suited for High-Mix, Low-Volume Production

To accommodate a wide range of customization needs, we have developed and introduced numerous production equipment suited for high-mix, low-volume production. This chapter presents two representative examples, highlighting the creative approaches behind their development.

3.1 Segment magnet insertion equipment

The process of inserting segment magnets (hereafter, "magnets") into the rotor is critical, as positional accuracy, adhesive application, and magnet adhesion directly affect motor performance and quality.

Traditionally handled manually, this process required flexible staffing to match fluctuating production volumes.

Figure 5 shows equipment that automatically inserts magnets into the rotor, enabling high-mix, low-volume production with improved motor quality. The following sections describe the key components and the creative approaches of the equipment.

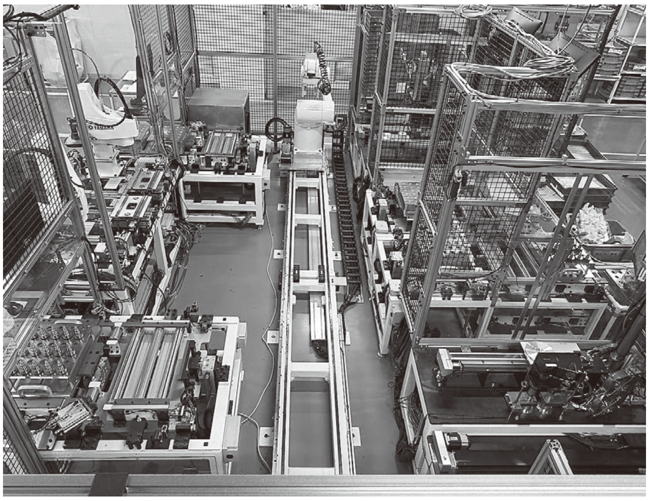


Fig. 5 Segment magnet insertion equipment

3.1.1 Magnet inspection using image processing

Magnets, supplied as unmagnetized loose pieces, are fed to the parts feeder, which orients them correctly. A SCARA robot picks up each magnet, and image processing inspects their appearance to automatically identify defects and dimensional issues. Defective magnets are removed, preventing flawed components from reaching downstream processes.

3.1.2 Parallel production using traveling rails and articulated robots

After inspection, magnets are inserted into the aligning jig and transported to the insertion process.

Because magnet insertion is time-intensive, two insertion stations were established for efficient production. Articulated robots on traveling rails distribute magnets to each station automatically, minimizing wait times and improving productivity.

3.1.3 Batch magnet attachment and high-frequency heating

A specified number of magnets are attached in batches on the alignment jig, ensuring positional accuracy and proper adhesion. High-frequency heating of rotors shortens the heating time within the process.

These approaches minimize insertion time, improve productivity, and ensure consistent quality.

3.2 Brake assembly and inspection

The electromagnetic brake (hereafter, “brake”), built inside the servo motor, holds the motor shaft in place when power is off. As it is a critical part for assuring safety, the brake assembly and inspection processes require high reliability and precise operations.

Traditionally, workers measured parts using micrometers and carefully selected suitable spacers—a time-consuming and attention-intensive process. To improve productivity, we integrated image processing technology and multiple sensors into a new brake assembly equipment, allowing automatic and accurate part handling. This automation significantly reduced labor hours while ensuring reliable assembly. Certain tasks, such as securing components to the conveyor pallet and tightening screws, remain manual. In high-mix, low-volume production, this appropriate combination of automated and manual work is essential.

Figures 6 and 7 show brake assembly and inspection equipment, arranged side by side for a one-piece production flow from assembly to inspection. We will highlight our key development features in designing the equipment.

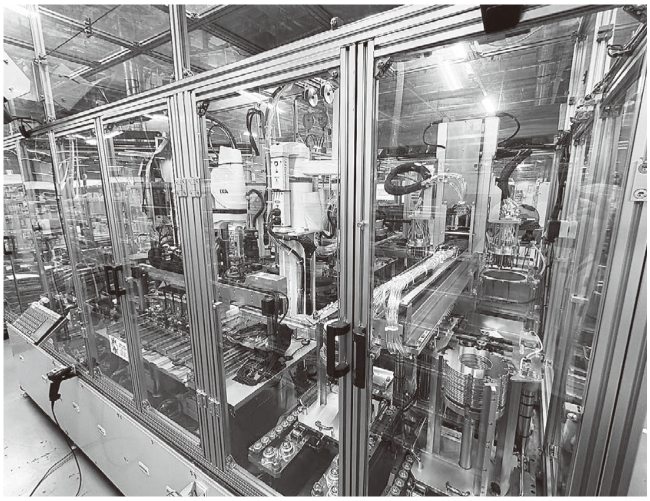


Fig. 6 Brake assembly equipment

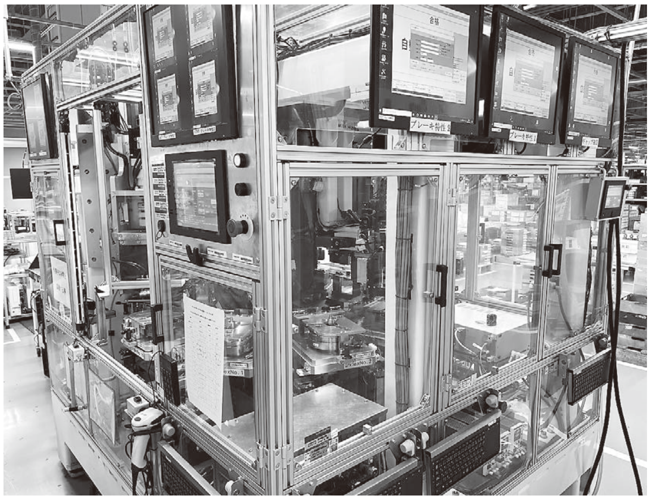


Fig. 7 Brake inspection equipment

3.2.1 Assembly using image processing

Brakes are assembled using SCARA and Cartesian robots. The yoke is placed first on the far bottom, followed by sequential stacking of the inner plate and friction plate. In the layering process, multiple cameras mounted on the robot hand calculate the positional difference of each part. These values are converted into robot coordinates to achieve high-precision positioning.

3.2.2 Automatic thickness measurement for proper spacer selection

The inner and friction plates are sandwiched between high-precision ceramic measuring plates from above and below, and the thickness is automatically measured using multiple displacement sensors. Based on this measured value, a suitable spacer that provides a sufficient gap between the yoke and inner plate is automatically selected and picked up. This time-consuming, concentrating process has now been automated, achieving improved productivity and stabilized quality.

3.2.3 Simultaneous inspection using an index table

After assembly, the brake undergoes various inspections before the product is completed. In the inspection process, the index table ensures synchronization with the assembly cycle. After securing each product on the conveyor pallet, the product automatically moves through each inspection station for characteristics testing, backlash inspection, and static friction inspection. Parallel execution allows all inspections to be completed within the assembly cycle time.

Through an effective combination of automated and manual processes, the assembly and inspection process achieves improved efficiency, productivity, and quality consistency.

4. Production Engineering Services

With the transition from a division-based system to a business company system, the Motion Company launched production engineering services as a new business.

This chapter provides an overview of production engineering services and introduces the production guidance system, as one of the company's key initiatives.

4.1 Overview of production engineering services

Production engineering services leverage our long-standing expertise in robot utilization, automation technologies, and production system construction to help customers solve challenges in their manufacturing processes. The services are categorized into the following three areas:

1. Design, manufacture, and sale of machinery and equipment that support customer production
2. Design, manufacture, and sale of automated equipment that improves customer productivity
3. Design, manufacture, and sale of production systems that enhance customer manufacturing quality

In particular, the third category involves providing customers with our production guidance system, which is used in our own production sites. This service has received strong interest from customers who have not yet digitized their work instructions or who want to maintain detailed work history records.

4.2 Production guidance system

The production guidance system is designed to enable high-quality manufacturing by ensuring that products are produced in the same standardized procedure—by anyone, without errors, and efficiently—based on work instructions derived from drawings. The main features of the system include:

1. Digitization of work procedures
2. Connection and control of external devices
3. Recording of work history as traceable data

For the first category, work processes (hereafter, "steps") are divided into individual steps, which are displayed sequentially on a monitor, as shown in Figure 8. Steps are presented with photos, drawings, and text for easy understanding, allowing anyone to perform the work regardless of skill level.

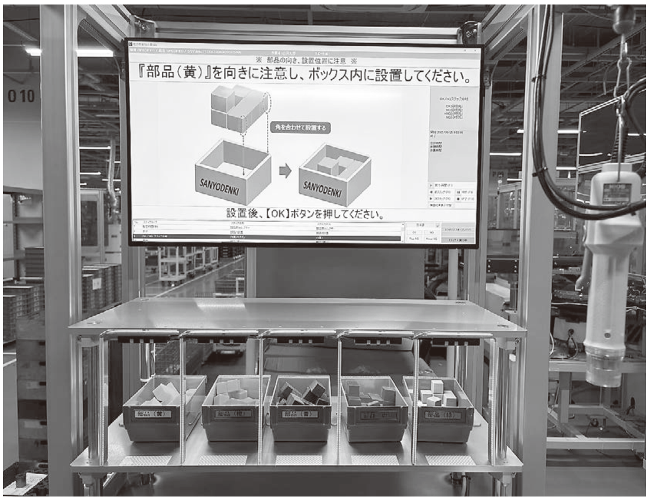


Fig. 8 Steps in the production guidance system

For the second category, each step is linked to external devices, for example, turning on LEDs attached to tools. Signals from sensors also control buzzers, guiding the operator visually and audibly. Moreover, values acquired from external devices can be used as criteria for step completion, ensuring work is performed without errors.

For the third category, all step information is stored in a database and can be used for analyzing work trends, identifying bottlenecks, and adjusting process balance. This contributes to efficient workflow management.

By implementing the production guidance system, high-quality products can be manufactured by anyone, without errors, and efficiently. The system supports operational reform and meets a wide range of customer needs.

5. Conclusion

This article has introduced three examples of technologies and core strengths of the Motion Company. These initiatives leverage our long-cultivated expertise in customized design and our production engineering capabilities, which enable us to manufacture numerous customized products efficiently and with high quality.

1. Customization tailored to customer equipment
2. Manufacturing equipment suited for high-mix, low-volume production
3. Production engineering services

The purpose of customization is to enhance the performance of customer equipment and strengthen market competitiveness. To achieve this, it is essential to thoroughly understand the customer’s equipment and provide optimal proposals based on our experience. Hearing customers say, “SANYO DENKI made it possible” or “They delivered an excellent product” is our source of pride and our contribution to society. We will continue to work closely with our customers and remain committed to delivering customized solutions that create new value.

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ø200 × 70 mm *San Ace 200* 9GA Type DC Fan

Yoshinori Miyabara　Hidetoshi Obayashi　Soichiro Okui　Toshiyuki Nakamura

1. Introduction

With the rapid advancement of AI technology and higher data-processing speeds, data centers are increasingly adopting high-performance server racks and heat exchangers equipped with CPUs and GPUs, generating demand for cooling fans that deliver high cooling performance with low power consumption.

As server racks commonly use multiple cooling fans to achieve high airflow, demand has been rising for a fan with an optimal diameter of ø200 mm.

We previously developed and launched the ø200 × 70 mm *San Ace 200* 9GV type DC Fan (hereinafter, “current product”). Now, in response to this market demand, we developed and launched the ø200 × 70 mm *San Ace 200* 9GA type DC Fan (hereinafter, “new product”).

This article introduces the features and performance of the new product.

2. Product Features

Figure 1 shows the new product.

The new product delivers lower power consumption and a lighter design than the current product, without changing the dimensions.

Fig. 1 ø200 × 70 mm *San Ace 200* 9GA type

3. Product Overview

3.1 Dimensions

Figure 2 shows the dimensions of the new product. The external dimensions and mounting hole dimensions are unchanged and compatible with the current product.

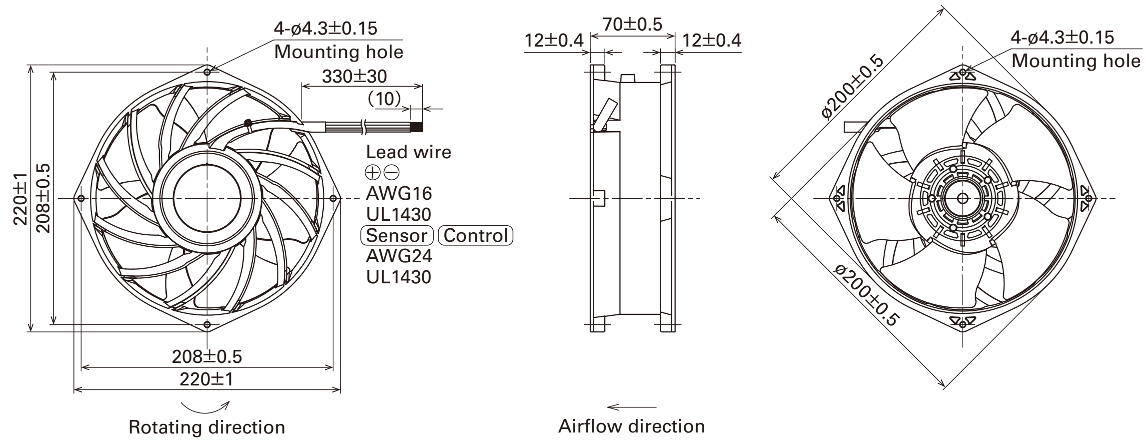


Fig. 2 Dimensions of the ø200 × 70 mm *San Ace 200* 9GA type (Unit: mm)

3.2 Specifications

3.2.1 General specifications

Table 1 shows the general specifications of the new product.

Table 1 General specifications of the ø200 × 70 mm *San Ace 200* 9GA type

Model No.	Rated voltage [V]	Operating voltage range [V]	PWM duty cycle* [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. airflow [m³/min]	Max. airflow [CFM]	Max. static pressure [Pa]	Max. static pressure [inchH$_2$O]	Sound pressure level [dB(A)]	Operating temperature range [°C]	Expected life [h]
9GA2048P0G001	48	36 to 60	100	8.0	384	7,800	30.7	1084	1350	5.40	81	-20 to +70	40,000 at 60°C (70,000 at 40°C)
			20	0.30	14.4	2,000	7.87	278	147	0.588	48		

* PWM input frequency is 25 kHz. Speed is 0 min^{-1} at 0% PWM duty cycle only for models that have no speed ratings at 0% listed. When the control terminal is open, the fan speed is the same as the speed at 100% PWM duty cycle.

3.2.2 Airflow vs. static pressure characteristics

Figure 3 shows the airflow vs. static pressure characteristics of the new product.

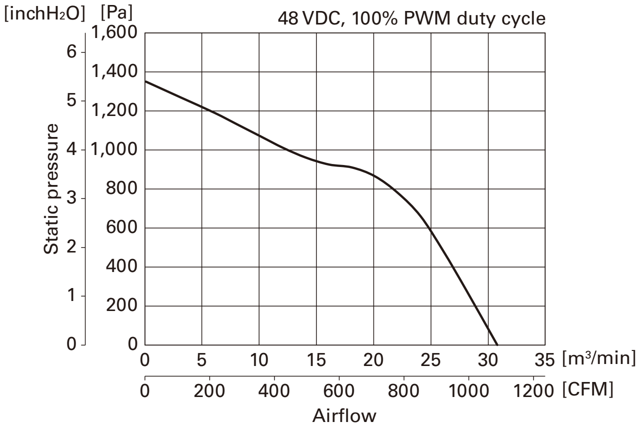


Fig. 3 Airflow vs. static pressure characteristics of the new product

3.2.3 PWM control

The new product has PWM control and is capable of controlling fan speed.

4. Key Points of Development

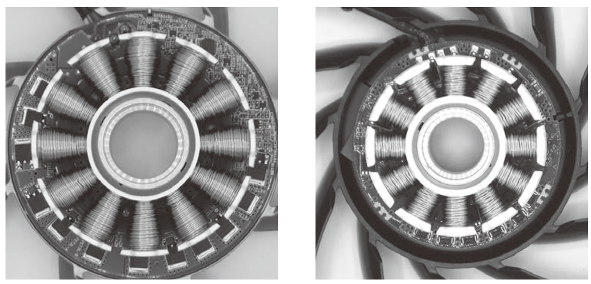
The new product uses a highly efficient 3-phase motor and newly designed impeller and frame shapes with high airflow efficiency, achieving the same cooling performance as the current product while reducing power consumption.

The key points of development are as follows.

4.1 Motor and circuit design

Figure 4 compares the motors of the current and new *San Ace 200* DC fans.

Both the new and current products use 3-phase drive motors. In this development, the motor and circuit board were downsized to improve airflow efficiency. While the outer diameter of the motor is approximately 20% smaller than that of the current product, we maintained equivalent motor efficiency by optimizing the winding design and using a high-strength magnet.



Current product New product

Fig. 4 Motors of the new and current products

4.2 Impeller and frame design

Figure 5 shows a comparison of the impeller and frame shapes for the new and current products.

The new product uses a smaller-diameter motor, allowing the boss at the center of the impeller and frame to be downsized, which increases the vent area. In addition, optimizing the shape of the impeller and frame blades improved airflow efficiency, contributing to reduced power consumption.

Furthermore, vent holes were added to the top of the impeller to enhance the motor's self-cooling, helping limit temperature rise in the electronic components and windings.

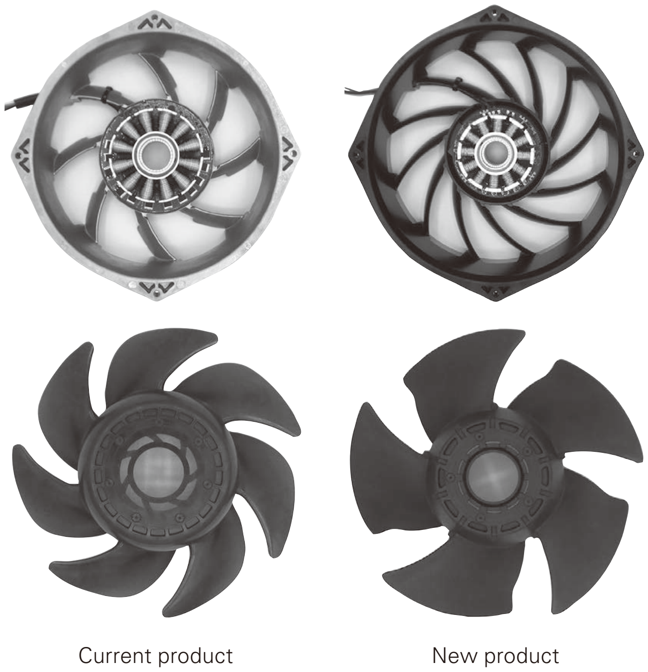


Fig. 5 Comparison of the impeller and frame shape for the new and current products

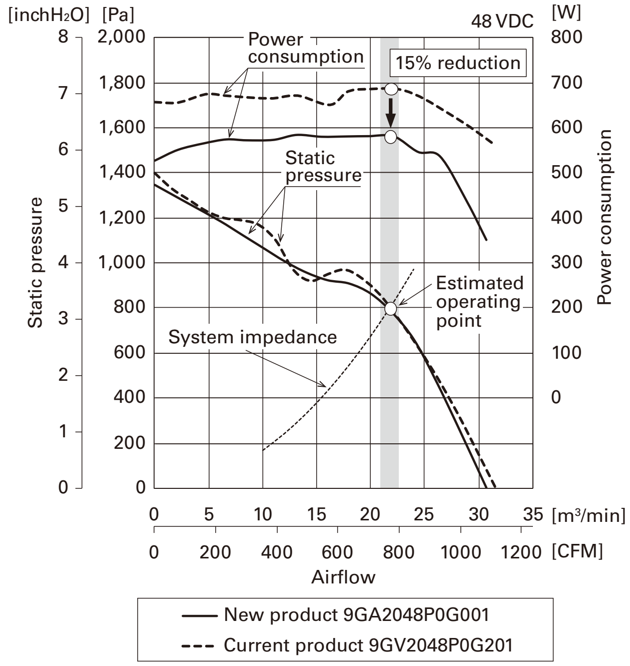


Fig. 6 Airflow vs. static pressure characteristics of the new and current products

5. Comparison of New and Current Products

5.1 Comparison of the airflow vs. static pressure characteristics and power consumption

Figure 6 compares the airflow–static pressure characteristics and power consumption of the new and current products.

At the estimated operating point in the figure indicating equivalent cooling performance, the new product boasts a 15% reduction in power consumption compared to the current product. Furthermore, in the range close to the maximum airflow, power consumption has been reduced by up to 36%.

5.2 Comparison of component count and product mass

By incorporating a new drive IC, the new product reduces the number of drive circuit components by approximately 60% from that of the current product. The reduction in motor size also decreases overall product mass by approximately 16%. This contributes to a lower environmental impact associated with fan manufacturing and transportation.

5.3 Environmental impact comparison

Figure 7 compares the CO_2 emissions of the new and current products over their life cycles.

Thanks to its reduced power consumption at the equivalent operating airflow compared to the current product, the new product emits 15% less CO_2 over its product life cycle. Through assessment of its environmental impact reduction, it has been certified as an Eco Product.

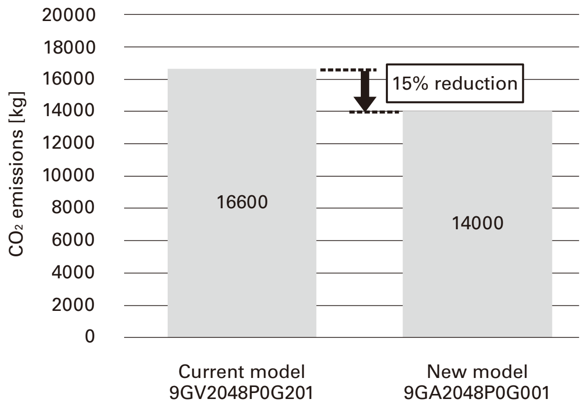


Fig. 7 CO_2 emissions comparison using our LCA calculation software (40,000 hours, when operating with the same operating airflow)

6. Conclusion

This article has introduced the features and performance of the newly developed ø200 × 70 mm *San Ace 200* 9GA type DC Fan.

The new product achieved lower power consumption than our current product while maintaining the same cooling performance. It also features a lighter design thanks to the downsized motor.

We will continue to help our customers create new value by swiftly addressing market demand and offering products that promote the reduction of environmental impacts.

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80 × 80 × 80 mm *San Ace 80* 9CRHA Type Counter Rotating Fan

Yoshihisa Yamazaki Kazuya Maruyama Ken Fujisawa Masashi Miyazawa

1. Introduction

With the rapid advancement of AI technology and growing demand, the GPU servers and communication equipment that support it have become increasingly critical as the backbone of today's economy.

At the same time, higher performance and greater density in these devices have led to a significant rise in internal heat generation. Many of these devices already use counter rotating fans for superior cooling, but further improvements in cooling performance are strongly required.

We previously developed and launched the 80 × 80 × 80 mm *San Ace 80* 9CRH type Counter Rotating Fan (hereinafter, "current product"). Now, in response to this market demand, we developed and launched the 80 × 80 × 80 mm *San Ace 80* 9CRHA type Counter Rotating Fan (hereinafter, "new product").

This article introduces the features and performance of the new product.

2. Product Features

Figure 1 shows the new product.

Compared to the current product, the new product achieves higher static pressure while maintaining the same dimensions.

3. Product Overview

3.1 Dimensions

Figure 2 shows the dimensions of the new product.

The external dimensions and mounting hole dimensions are compatible with the current product.

Fig. 1 80 × 80 × 80 mm *San Ace 80* 9CRHA type

3.2 Specifications

3.2.1 General specifications

Table 1 shows the general specifications of the new product.

3.2.2 Airflow vs. static pressure characteristics

Figure 3 shows the airflow vs. static pressure characteristics of the new product.

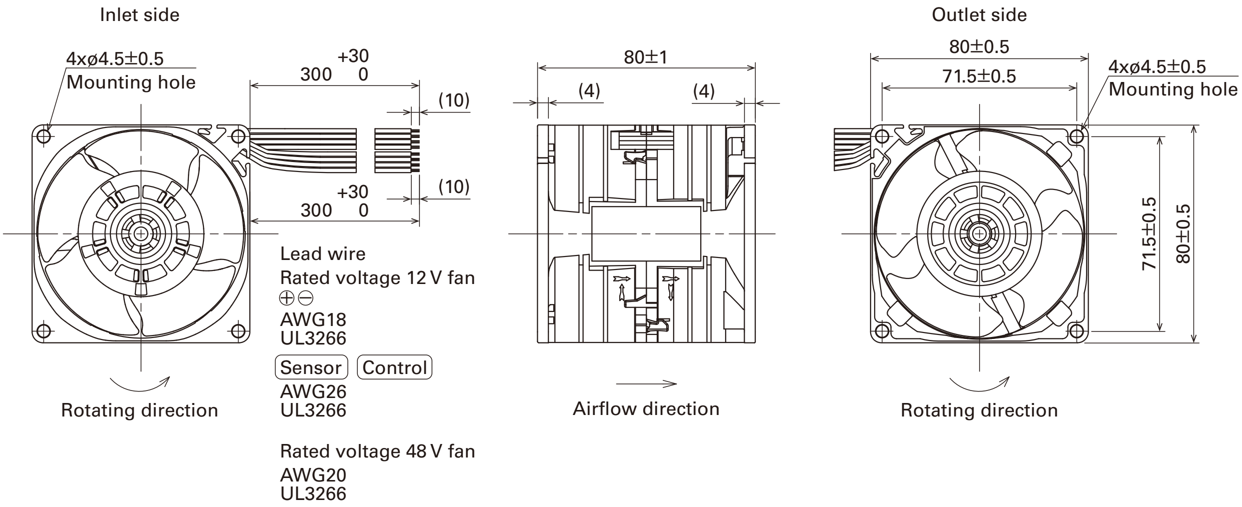

Fig. 2 Dimensions of 80 × 80 × 80 mm *San Ace 80* 9CRHA type (Unit: mm)

Table 1 General specifications of 80 × 80 × 80 mm *San Ace 80* 9CRHA type

Model no.	Rated voltage [V]	Operating voltage range [V]	PWM duty cycle* [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]		Max. airflow		Max. static pressure		Sound pressure level [dB(A)]	Operating temperature range [°C]	Expected life [h]
						Inlet side	Outlet side	[m^3/min]	[CFM]	[Pa]	[inchH$_2$O]			
9CRHA0812P8J001	12	10.8 to 12.6	100	12.0	144	18500	19300	5.65	199	2700	10.8	85	-20 to +70	40000 at 60°C (70000 at 40°C)
			20	0.20	2.40	2300	2500	0.70	24.7	52.0	0.208	36		
9CRHA0848P8J001	48	40.8 to 60.0	100	2.8	135	18500	19300	5.65	199	2700	10.8	85		
			20	0.11	5.28	2300	2500	0.70	24.7	52.0	0.208	36		

* PWM input frequency is 25 kHz. Speed is 0 min^{-1} at 0% PWM duty cycle only for models that have no speed ratings at 0% listed. When the control terminal is open, the fan speed is the same as the speed at 100% PWM duty cycle.

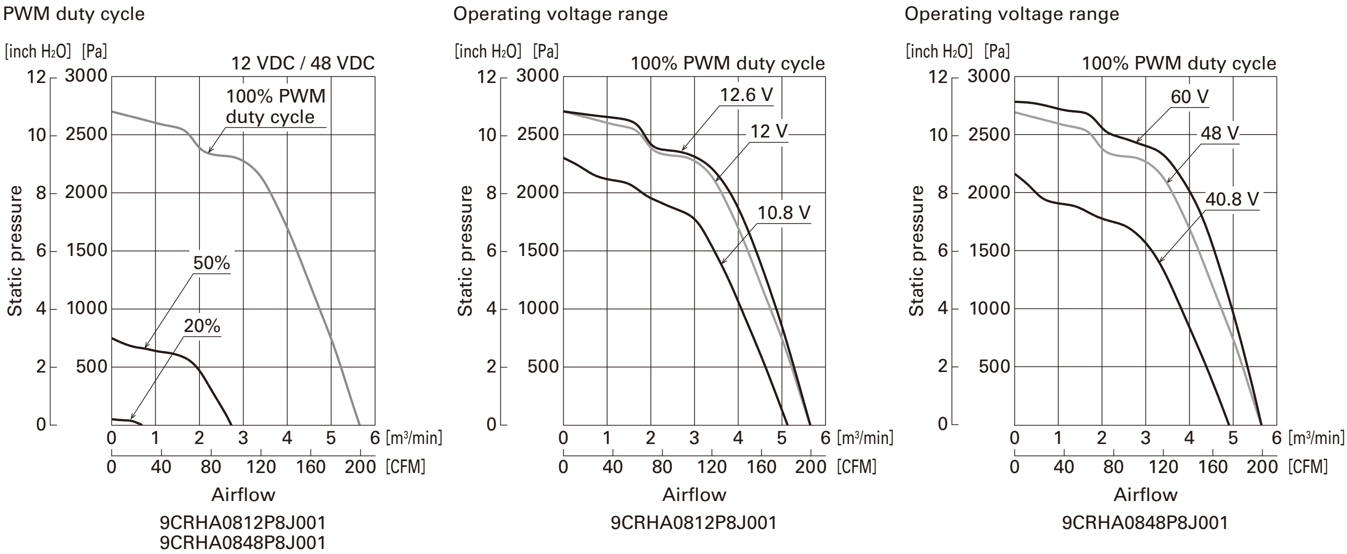

Fig. 3 Airflow vs. static pressure characteristics of the new product

3.2.3 PWM control

The new product has PWM control and is capable of controlling fan speed.

4. Key Points of Development

The new product features a highly efficient 3-phase motor and redesigned impeller and frame for high-speed, high-static-pressure performance, achieving lower power consumption under high-load conditions.

Space-saving design measures minimize the impact on the devices in which the fan is installed.

The key points of development are as follows.

4.1 Motor design

To increase the fan speed beyond that of the current product, it is essential to increase motor efficiency and reduce vibration, as higher speeds typically result in an increase in both power consumption and vibration.

In the new product, the winding configuration and phase-switching timing were optimized to improve motor efficiency under high-load conditions. To reduce vibrations, a specially designed magnetizing yoke was used to lower cogging torque, enabling higher speeds.

4.2 Impeller and frame design

4.2.1 Characteristics improvement by impeller and frame design

Figure 4 shows a comparison of the impeller and frame shapes for the new and current products. Compared to the current product, the new product features an optimized impeller shape and frame spoke shape.

Notably, the number of spokes was increased and the impeller mounting angle was adjusted to achieve higher efficiency and higher static pressure.

Key factors in cooling fans include blade shape, frame shape, and fan speed. As this product is a counter rotating fan, these factors double in complexity compared to standard axial fans, resulting in numerous possible combinations.

Accordingly, by repeatedly performing design exploration and prototype evaluation through simulation, we efficiently identified the optimal shapes to achieve higher performance.

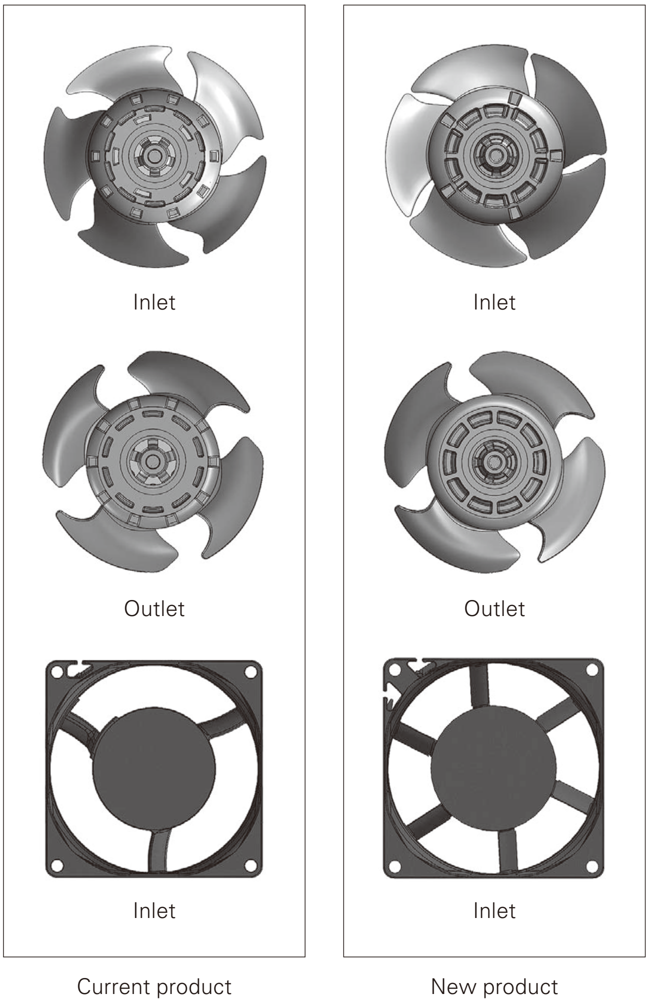

Fig. 4 Comparison of the impeller and frame shape for the new and current products

4.2.2 Improved device integration through frame design

Figure 5 compares the shapes of the new and current products. In the current product, only one lead-wire outlet is provided on the flange on both the inlet and outlet sides, limiting wiring layout options.

The new product incorporates a redesigned structure that provides two lead-wire outlets with a centrally located mounting hole.

This enhances flexibility in fan placement and wiring, even in high-density equipment layouts, helping reduce the overall system footprint.

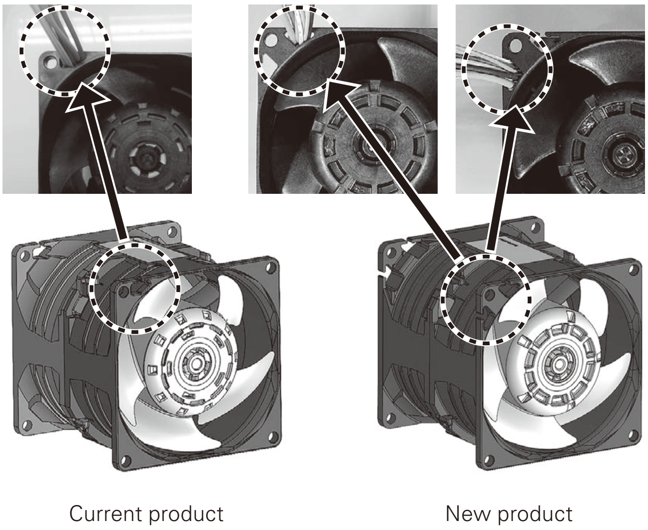

Fig. 5 Comparison of the lead-wire outlet configurations for the new and current products

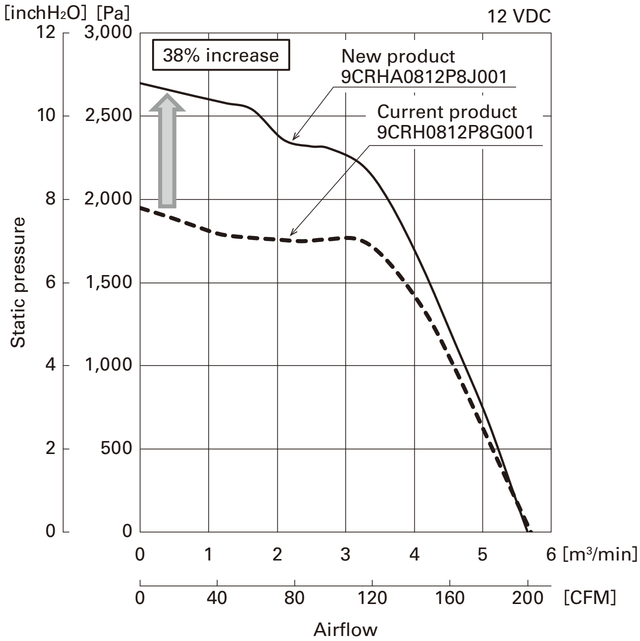

Fig. 6 Airflow vs. static pressure characteristics of the new and current products

5. Comparison of New and Current Products

5.1 Comparison of airflow vs. static pressure characteristics

Figure 6 compares the airflow vs. static pressure characteristics of the new and current products.

The new product maintains the same maximum airflow as the current product while increasing maximum static pressure by 38%, achieving higher static-pressure performance.

5.2 Power consumption and sound pressure level comparison

Figure 7 compares the power consumption and sound pressure level of the new and current products at equivalent airflow within the estimated operating range.

Within this range, the new product reduces power consumption by 21% and sound pressure level by 2 dB(A) compared to the current product, achieving both high efficiency and low noise.

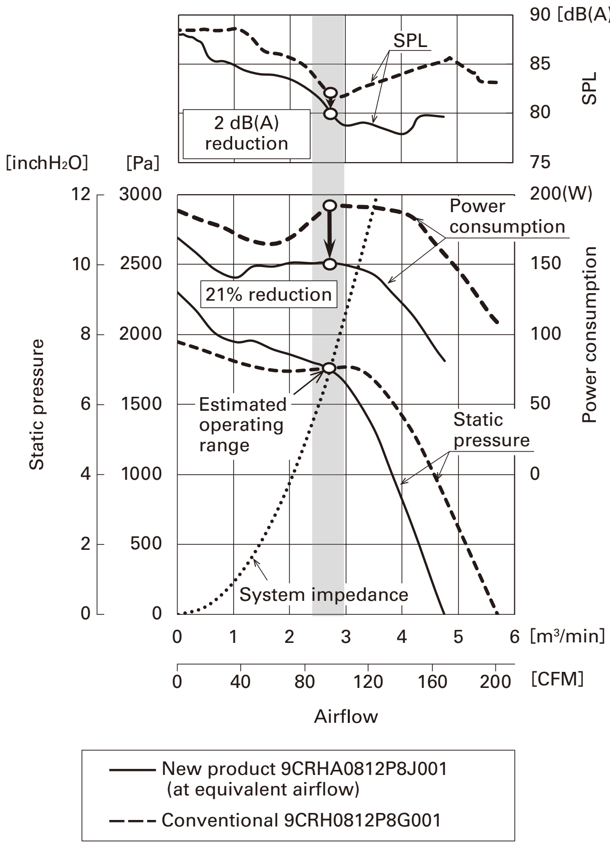

Fig. 7 Power consumption and sound pressure level of the new and current products at equivalent airflow within the estimated operating range

5.3 Environmental impact comparison

Figure 8 compares the CO_2 emissions of the new and current products over their life cycles.

Thanks to its reduced power consumption at equivalent operating airflow compared to the current product, the new product emits 21% less CO_2 over its product life cycle. Through assessment of its environmental impact reduction, it has been certified as an Eco Product.

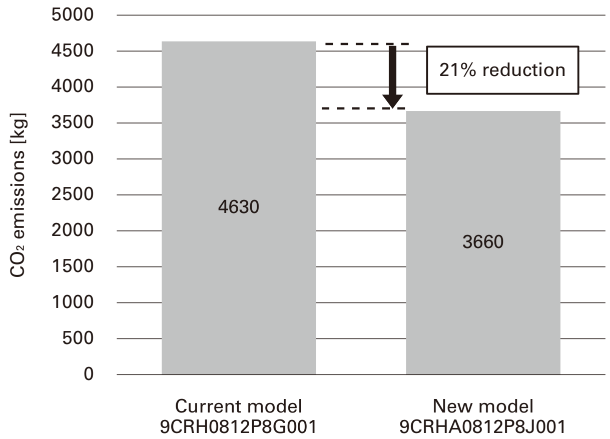

Fig. 8 CO_2 emissions comparison using our LCA calculation software (40,000 hours, when operating with the same operating airflow)

6. Conclusion

This article has introduced the features and performance of the newly developed 80 × 80 × 80 mm *San Ace 80* 9CRHA type Counter Rotating Fan.

The new product achieved higher static pressure and lower power consumption than our current product while maintaining the same airflow.

It also helps reduce environmental impact and saves space in equipment.

We will continue to help our customers create new value by swiftly meeting market demand and offering eco-friendly products.

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Development of *SANMOTION G* 48 VDC Servo Systems

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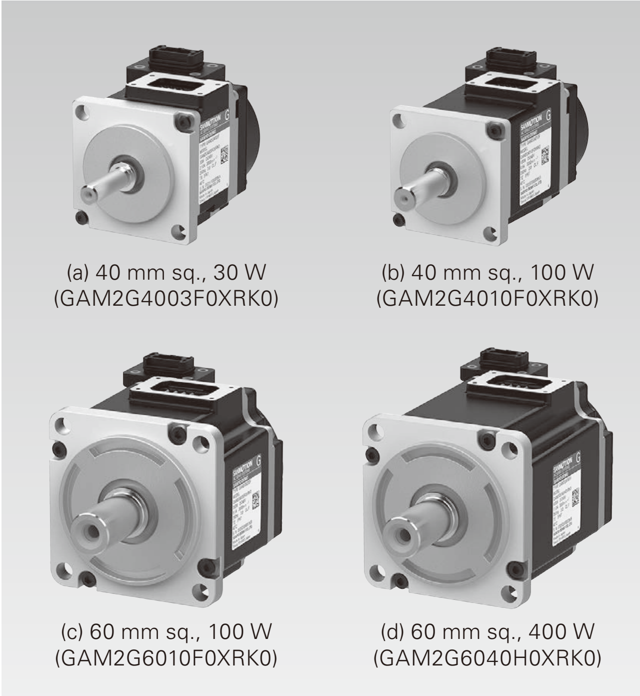
1. Introduction

In semiconductor manufacturing equipment, medical equipment, agricultural machinery, and food manufacturing equipment, demand is increasing for servo systems that operate on power supplies of up to 60 VDC (safety extra-low voltage, or SELV), which reduces the risk of electric shocks and fires.

Furthermore, autonomous mobile robots (AMRs) and other battery-powered drive systems are becoming widespread as industries work to address labor shortages and improve productivity.

To provide servo motors and servo amplifiers that are ideal for semiconductor manufacturing equipment and battery-powered drive systems, we developed the compact, lightweight, high-efficiency, and low-noise *SANMOTION G* 48 VDC servo systems, designed for both powerful and user-friendly features.

This article provides an overview of the product, followed by its key features and major development points.



(a) 40 mm sq., 30 W (GAM2G4003F0XRK0)
(b) 40 mm sq., 100 W (GAM2G4010F0XRK0)
(c) 60 mm sq., 100 W (GAM2G6010F0XRK0)
(d) 60 mm sq., 400 W (GAM2G6040H0XRK0)

Fig. 1 Servo motors

2. Product Overview

This chapter presents the overview of the *SANMOTION G* 48 VDC servo motors and amplifiers.

2.1 Servo motors

Figure 1 shows some of the new servo motors. Table 1 lists the servo motor lineup, and Table 2 shows the specifications of servo motors and encoders. We have expanded our medium-inertia motors (GAM2 series) to seven models, ranging from 40 mm sq., 30 W to 60 mm sq., 400 W.

In addition to the five models equivalent to the current *SANMOTION R* series(1), two new 60 mm sq. models—200 W and 400 W—have been added, both compatible with the 80 A servo amplifier.

The product features an integrated power cable and holding brake cable, along with a new 6-core integrated connector.

Table 1 Servo motor lineup

Flange size	Rated output	Servo motor model no.	Applicable servo amplifiers	Newly added model
40 mm sq.	30 W	GAM2G4003F0	40 A	–
	50 W	GAM2G4005F0		–
	100 W	GAM2G4010F0		–
60 mm sq.	100 W	GAM2G6010F0		–
	200 W	GAM2G6020D0		–
	200 W	GAM2G6020F0	80 A	✓
	400 W	GAM2G6040H0		✓

Our encoder lineup includes a battery-less absolute encoder with a maximum resolution of 27 bits and a single-turn absolute encoder, delivering high resolution. Customers can choose from options with or without a

Table 2 Servo motor and encoder specifications

Servo motor model no.				Medium-inertia: GAM2G						
				4003F0	4005F0	4010F0	6010F0	6020D0	6020F0	6040H0
Flange size		–	mm	40 × 40	40 × 40	40 × 40	60 × 60	60 × 60	60 × 60	60 × 60
Rated output		P_R	W	30	50	100	100	200	200	400
Rated torque		T_R	N·m	0.098	0.159	0.318	0.318	0.637	0.637	1.27
Continuous torque at stall		T_S	N·m	0.108	0.167	0.32	0.353	0.637	0.637	1.27
Peak torque at stall		T_P	N·m	0.24	0.56	0.98	0.84	1.5	2.2	4.0
Rated speed		N_R	min^{-1}	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Maximum speed		N_{max}	min^{-1}	6,500	6,500	6,500	6,500	5,000	6,500	4,000
Rated armature current		I_R	Arms	2.10	3.7	4.5	6.4	6.4	9.1	11.0
Continuous armature current at stall		I_S	Arms	2.00	3.7	4.4	6.4	6.4	8.7	10.5
Peak armature current		I_P	Arms	4.5	13.5	14.8	14.8	14.8	30	33
Rotor inertia	**w/o brake**	J_M	$\times 10^{-4}$kg·m^2 (GD^2/4)	0.0233	0.0324	0.0600	0.143	0.247	0.247	0.466
	w/ brake			0.0303	0.0394	0.0670	0.201	0.306	0.306	0.524
Encoder inertia		J_S		0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
Motor length	**w/o brake**	LL	mm	51.5	55.5	68	55.5	65.5	65.5	85.5
	w/ brake			84	88	100.5	77.5	91.5	91.5	111.5
Mass	**w/o brake**	WE	kg	0.25	0.29	0.39	0.59	0.8	0.8	1.2
	w/ brake			0.44	0.48	0.58	0.88	1.2	1.2	1.6
Encoder resolution		–	–	17-bit (131,072 steps), 20-bit (1,048,576 steps), 23-bit (8,388,608 steps), 27-bit (134,217,728 steps)						
Multi-turn encoder		–	–	Batteryless						

holding brake, with or without an oil seal, and with either a circular or keyway shaft.

2.2 Servo amplifiers

Figure 2 shows some of the new servo amplifiers. The power supply and motor power connectors were changed from screw-fitting type to spring type push-pull connectors. By standardizing them with the 10 to 50 A models of the 200 V and 100 V *SANMOTION G* series, wiring workability has been improved.

As shown in Table 3, a total of 12 models are available, depending on the combination of servo motor and interface specifications with the host controller. The current[1] *SANMOTION R* (RS2K) offers rated outputs ranging from 30 to 200 W, but the new product adds servo motors and servo amplifiers capable of driving with a rated output of up to 400 W. This enables use in higher-output and larger equipment than before.

The interface, previously limited to EtherCAT[2], has been expanded to two types: EtherCAT and analog/pulse train command input. This addition broadens the interface options. The analog/pulse train command input type is available in both sinking and sourcing types as a general-purpose output specification.

Table 4 shows the main specifications of the new servo amplifiers. The responsiveness has been improved

(a) 40 A,
EtherCAT type
(GADSK04AH24)

(b) 80 A,
Analog/pulse input type
(GADSK08AA22)

Fig. 2 Servo amplifier

compared to the current model, and servo performance has been enhanced with new functions such as voltage feed-forward control, PWM control without current limiting, and model-based friction compensation.

To ensure use in various regions and environments, environmental durability against altitude, operating ambient temperature, and vibration resistance has been improved, further enhancing reliability. Moreover, the product has been equipped with an extensive range of monitoring functions—for estimating remaining part life and checking power supply condition and communication quality—further improving maintainability.

Table 3 Servo amplifier product lineup

Amplifier capacity	Compatible motors	Interface	General output (sinking/sourcing)	Built-in regenerative resistor	Servo amplifier model no.	Newly added model
40 A	30 to 200 W	EtherCAT	Common	Yes	GADSK04AH24	–
				No	GADSK04LH24	–
		Analog/ pulse train	Sinking type	Yes	GADSK04AA22	✓
				No	GADSK04LA22	✓
			Sourcing type	Yes	GADSK04AB22	✓
				No	GADSK04LB22	✓
80 A	200 W 400 W	EtherCAT	Common	Yes	GADSK08AH24	✓
				No	GADSK08LH24	✓
		Analog/ pulse train	Sinking type	Yes	GADSK08AA22	✓
				No	GADSK08LA22	✓
			Sourcing type	Yes	GADSK08AB22	✓
				No	GADSK08LB22	✓

Table 4 Servo amplifier main specifications

Amplifier capacity		40 A	80 A
Control power supply voltage range		24 VDC ±10%	
Main circuit power supply voltage range		48 VDC ±10%	
Compatible motors		30 to 200 W	200 W, 400 W
Continuous output current / Peak current		6.4 Arms / 14.8 Arms	12.0 Arms / 36.0 Arms
Altitude / Operating ambient temperature / Vibration resistance		2,000 m or less / 0 to 60˚C / 6.0m/s^2	
Dimensions (H × W × D)		160 × 40 × 85	160 × 45 × 110
Mass		0.5 kg	0.7 kg
Structure / Cooling system		Tray type / Passive air cooling	
Compatible motor types		• Rotary servo motors • Linear servo motors • Direct-drive motors	
Compatible encoders		• Absolute encoders (battery-less, single-turn, and battery backup types) • Wire-saving incremental encoder • HEIDENHAIN's EnDat 2.2 encoder(2)	
Performance and functions	Responsiveness and maximum resolution	• 1,500 Hz (velocity loop frequency response) • 134,217,728 steps per rotation (27 bit)	
	Control functions, compensation functions	• Tandem operation control • Dual position feedback control • Quadrant projection compensation • Friction compensation • Gravity compensation • Disturbance observer	
	Interface	• EtherCAT, analog/pulse train command input	
	Vibration control, resonance suppression	• Model-following vibration suppression • FF vibration suppression • Vibration suppression for trajectory control • Adaptive notch filter • CP vibration suppression control • Minor-vibration control • Torque command notch filter (variable width)	
	Servo tuning	• Frequency characteristics measurement • Advanced tuning • Auto tuning responsiveness (7 profiles, 40 levels)	
	Start-up, monitoring, diagnosis	• Virtual motor operation • Drive recorder • System power consumption monitoring • Input power supply monitoring • Control power supply frequency monitoring • Encoder/EtherCAT communication quality monitoring • Remaining electrolytic capacitor life • Regenerative resistor power consumption monitoring • Relay counter • Encoder temperature monitoring • Amplifier temperature monitoring • Relay sticking detection • Relay welding detection	
Compliance with standards	UL/CSA	UL 61800-5-1 / C22.2 No.274-13	
	Low Voltage Directive / EMC Directive	EN 61800-5-1 / EN 61800-3, EN 61326-3-1	
	Functional safety	ISO13849-1/PL=e, EN61508/SIL3, EN62061/maximum SIL 3	
	KC Mark	KS C 9610-6-2, KS C 9610-6-4	
	Other	UKCA Mark, RoHS Directive	

3. Powerful Servo Performance

3.1 High-power, high-precision servo motor

For the new product, we have significantly reduced the motor length by optimizing the electromagnetic field structure and winding specifications of the servo motor, as well as by downsizing the encoder. These smaller servo motors, combined with high torque characteristics, have resulted in high torque density compared to the current *SANMOTION R* series.

Figure 3 shows a comparison of peak torque density. Compared to the current product, the peak torque density has been improved by 39%.

The developed encoder is a high-resolution, battery-less absolute encoder with selectable resolutions of 17, 20, 23, or 27 bit. Higher encoder resolution enables stable repeatability and highly responsive positioning.

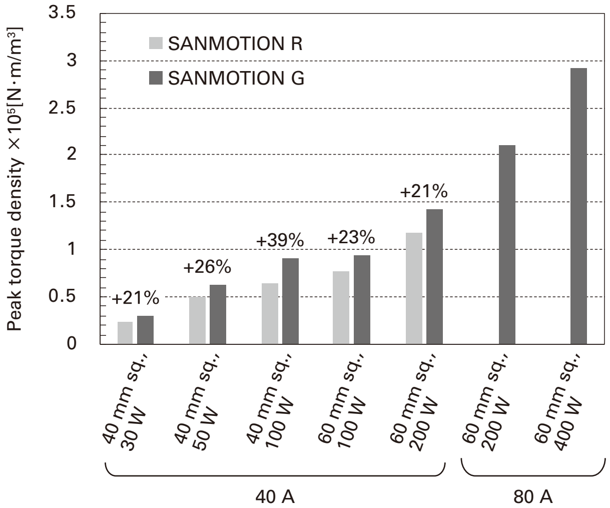


Fig. 3 Comparison of peak torque density

3.2 Extended output range

Figure 4 shows a comparison of torque vs. rotation speed characteristics (T-N characteristics). By optimizing the winding specification, the maximum motor speed has been increased from 5,000 min^{-1} to 6,500 min^{-1} over the current model.

For the servo amplifier, we improved the voltage utilization rate and the output current in order to increase the motor-applied voltage in the voltage saturation range. This has increased the motor torque during high-speed rotation by up to 14%.

As a result, the motor's output range expands by up to 36%, enabling shorter acceleration and deceleration times.

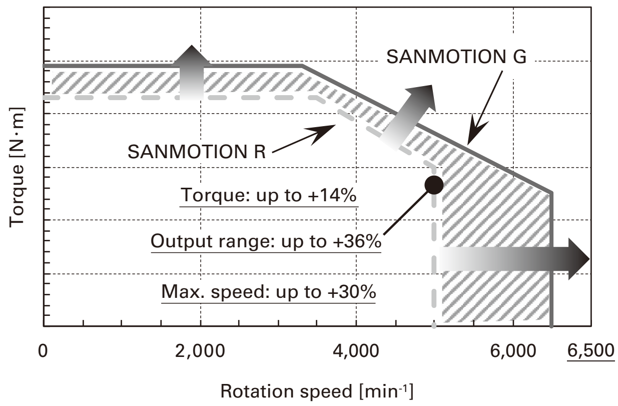


Fig. 4 Comparison of servo motor T-N characteristics

3.3 Improved responsiveness and shortened positioning settling time

Figure 5 shows the closed loop frequency response for the velocity control system. The responsiveness of the current control system has been doubled over the current model by increasing the control cycle speed and improving the current detection accuracy. By improving the torque control system, the frequency response of the velocity control system has been improved by approximately 2.2 times (1.5 kHz) over the current model.

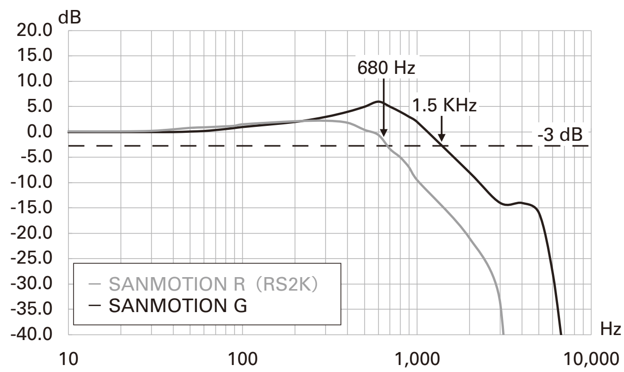


Fig. 5 Comparison of frequency response in velocity control system

Figure 6 shows positioning settling characteristics.

Using the "SETUP SOFTWARE" tuning function (Advanced Tuning), the positioning settling time has been reduced by 1/8 over the current model by compensating for the impact of friction and gravity that hinders settling.

This contributes to improved productivity by suppressing device vibration while shortening overall takt time.

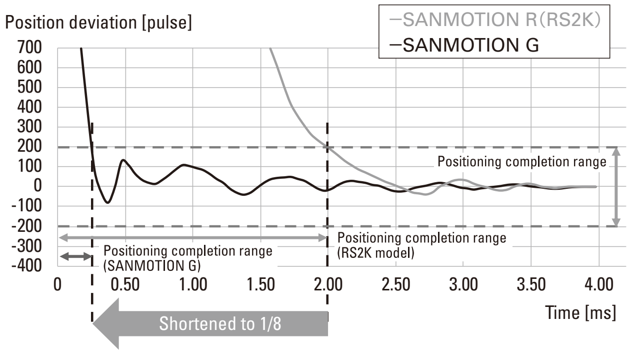


Fig. 6 Positioning settling characteristics

3.4 Environmental durability

Table 5 compares the environmental durability of the new model to that of the current model.

During the design process, environmental durability was enhanced through structural-strength simulations, thermal simulations, and verification testing using actual devices.

Compared to the current model, the operating altitude of the new model has been doubled from 1,000 m to 2,000 m. The vibration resistance of the servo motor has also been doubled from 24.5 m/s² to 50 m/s², while the operating temperature of the servo amplifier has been increased 1.5 times from 40°C to 60°C. This enables use in harsher environments.

Table 5 Environmental durability comparison with the current product

Items	Product	SANMOTION R (Current product)	SANMOTION G (New product)
Altitude	Motor	1,000 m or below	2,000 m max. (may require derating)
	Amplifier		
Vibration resistance	Motor	24.5 m/s² (10 Hz to 2 kHz)	50 m/s² (10 Hz to 2 kHz)
	Amplifier	4.9 m/s² (10 Hz to 55 Hz)	6.0 m/s² (10 Hz to 55 Hz)
Ambient temperature	Amplifier	0 to 40°C	0 to 60°C (may require derating)
Ambient humidity	Amplifier	90% RH or less (non-condensing, non-frozen)	95% RH or less (non-condensing, non-frozen)

4. Environmental Friendliness

4.1 High-efficiency, compact, lightweight servo motor

Figure 7 compares the motor length and Figure 8 compares the motor weight of the current and new models. As mentioned earlier, the servo motor's length and weight have been reduced by enhancing the electromagnetic design, optimizing the motor wiring, and downsizing the encoder. The motor length and mass have been shortened by up to 19% and 32%, respectively.

Additionally, the shorter and lighter motor has reduced material usage by up to 37%. To reduce motor losses, we achieved up to a 3.2% increase in efficiency by optimizing the electromagnetic design, improving the winding fill factor, and using low-loss materials.

Use in combination with a battery-less absolute encoder eliminates the need for battery backup for retaining multi-turn data when the power is turned OFF.

As a result, no periodic battery replacement is required, contributing to natural resource conservation, reduced industrial waste, and improved maintainability.

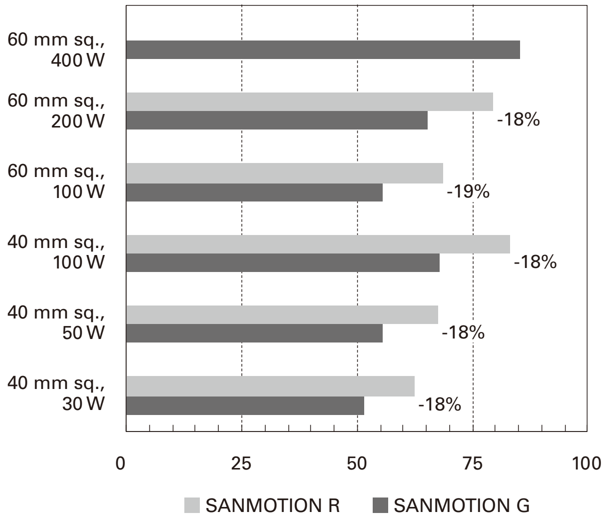


Fig. 7 Comparison of motor length (Without holding brake)

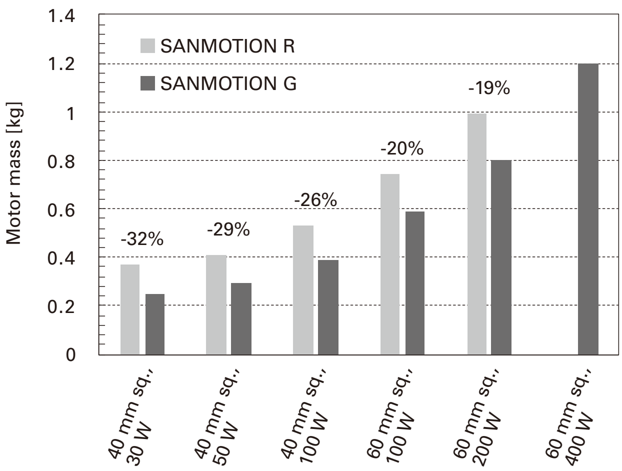


Fig. 8 Comparison of motor mass (Without holding brake)

4.2 High-efficiency servo amplifier

To increase the torque and responsiveness of the servo motor, we improved the rated output current of the servo amplifier by 7% and its peak output current by 5%, while also increasing the switching frequency of the power device by 16%.

Increased output current and faster switching frequency usually cause higher losses in power devices, resulting in lower efficiency. However, by using a low-loss power device, we reduced the power loss by up to 12.8% and improved the efficiency by up to 1.6%. This resulted in up to 9.8% lower CO_2 emissions.

4.3 High-rigidity, lightweight servo amplifiers

As shown in Figure 9, we made the die-cast parts thinner.

Through structural analysis and redesign of the cross-section, we successfully reduced mass while increasing rigidity. As a result, we achieved a 31% reduction in the die-cast mass and 28% increase in natural frequency.

This reduced the servo amplifier mass by up to 9% and increased vibration resistance by 1.2 times from 4.9 m/s² to 6.0 m/s².

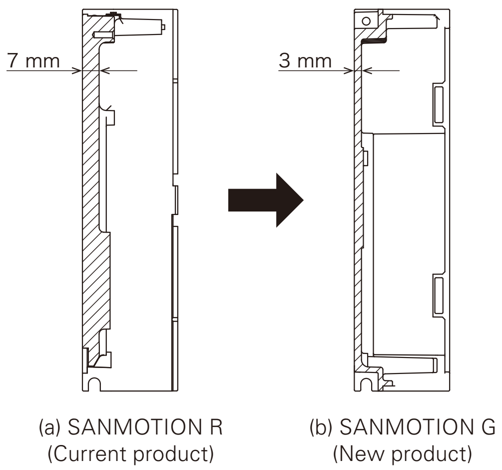


Fig. 9 Comparison of Cross-Sections of Die-Cast Parts

4.4 Initiatives to reduce environmental impact

As shown in Figure 10, the screen printing on the front cover has been replaced with laser markings, eliminating the use of ink on the resin cover.

This change reduces environmental impact and enhances recyclability, along with reduced CO_2 emissions through the aforementioned improvements in efficiency and weight reduction.

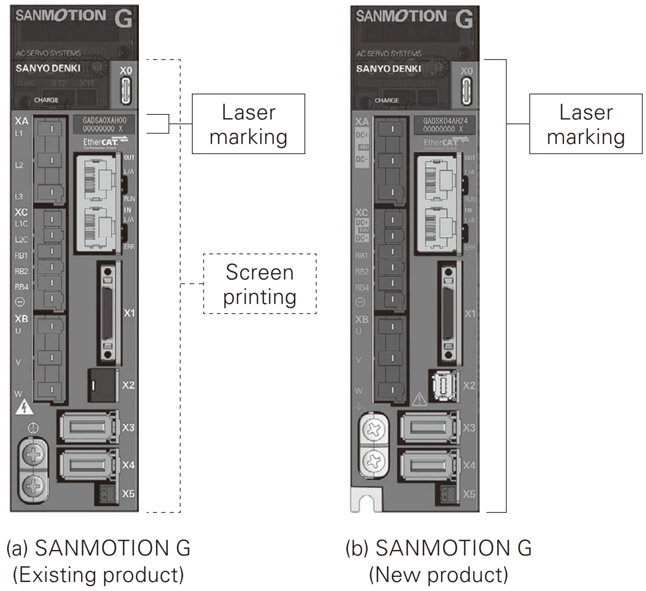


Fig. 10 (a) Screen printing and (b) laser marking

5. Friendliness to customers

5.1 Reduced cabling

The current model uses separate power and holding brake cables, but the new model integrates them into a single cable, as shown in Figure 11, reducing the number of required components.

The new model also maintains the same flange dimensions, mounting dimensions, and output shaft shape as *SANMOTION R* series to ensure mounting compatibility.

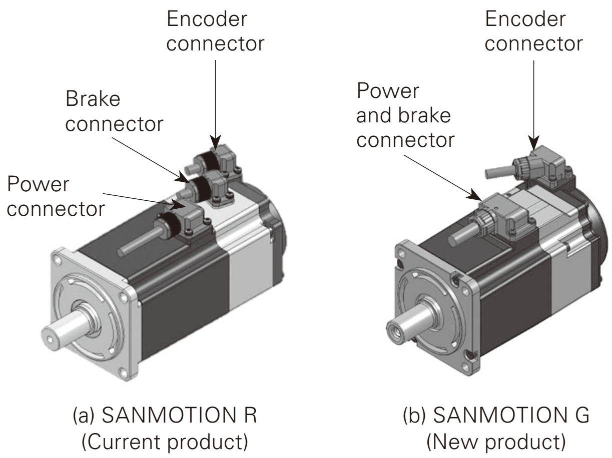


Fig. 11 Servo motor connectors

5.2 Lineup combining safety and scalability

Under international standards like IEC and UL, products running on 60 VDC or less are classified as safe for direct human contact.

Accordingly, the new product falls within a less restrictive safety category, making it easier for customers to obtain certification for their equipment. The product is therefore ideal for medical equipment, semiconductor manufacturing equipment, and battery-powered drive systems.

In addition to EtherCAT, analog and pulse-train command inputs have been added. We have also expanded the lineup with a 400 W model, doubling the output of the current 200 W model. This makes the product suitable for higher-output and larger wafer conveying robots as well as AMRs.

The external dimensions of the current model have been maintained to ensure installation compatibility, allowing customers to replace existing equipment with *SANMOTION G* products without redesigning their systems.

6. Key Points of Development

This chapter introduces the development considerations and design innovations incorporated into this product series.

6.1 Expanded operating temperature range of the servo amplifier

Figure 12 shows the heat dissipation structure of the servo amplifier. Conventionally, heat-generating parts such as diodes and FETs were cooled directly. However, because semiconductor devices contain IC chips sealed in molded resin, heat-dissipation efficiency was limited.

For the new product, we employed a structure that transfers heat to the radiating fins through the PCB pattern. Increasing the pattern area accelerates heat dissipation and effectively suppresses the temperature rise of the parts.

This structure is further combined with a heat dissipation sheet with high thermal conductivity to limit the internal temperature increase. In addition, heat generation itself was reduced by using compact, low-loss semiconductor devices.

These improvements have increased the maximum operating temperature under natural air cooling from 40°C to 60°C, a 1.5 times increase, enabling use in harsher environments.

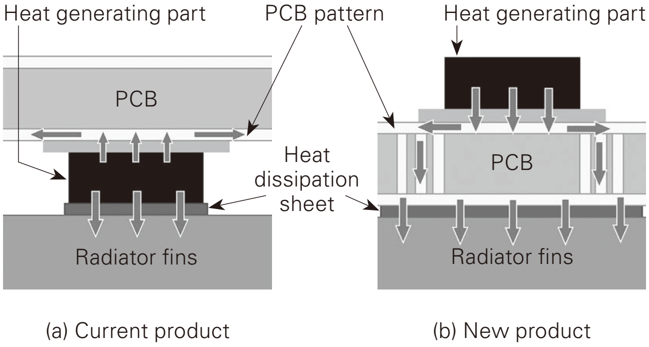


Fig. 12 Heat dissipation of the parts

6.2 Servo amplifier improved installability

We previously recommended vertical installation of the servo amplifier because horizontal mounting limits convection airflow and increases internal temperatures. However, this restriction made it difficult for customers to reduce the height of automated guided vehicles (AGVs) and AMRs.

To address this issue, we prepared a dedicated attachment[(3)] that enables horizontal installation and lowers the amplifier's center of gravity. In addition, as shown in Figure 13, we adopted a structure that allows an optional cooling fan to be mounted, enabling operation at ambient temperatures of up to 60°C even when installed horizontally.

This has contributed to height reductions of customer equipment and provides greater flexibility in mounting configurations.

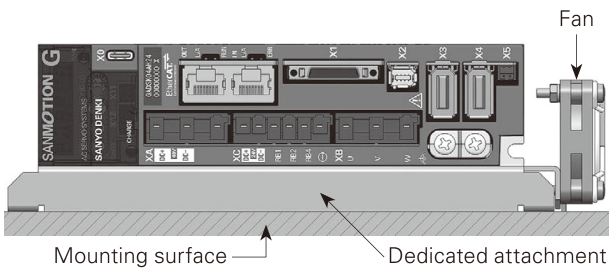


Fig. 13 Horizontal mounting of servo amplifier

6.3 Increased servo motor productivity and production quality

All servo motor models feature an aluminum frame, and the structural design has been standardized using a common design. Because all models share the same basic structure, switching production between models can be done quickly. Moreover, stator and rotor assembly—key processes in motor manufacturing—have been automated for improved productivity.

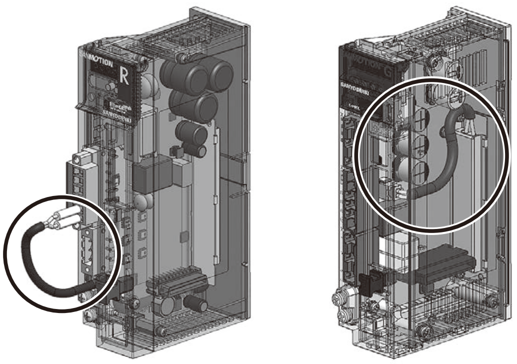
For the encoder, new automated equipment was introduced to produce the rotating disk module. The rotating disk centering and bonding processes that were previously carried out manually are now automated using cameras and robots, greatly improving productivity.

6.4 Increased servo amplifier productivity and production inspection quality

6.4.1 Increased productivity

Figure 14 shows built-in regenerative resistor wiring. The current model requires the resistor wiring to be routed out of the servo amplifier and connected to a front connector, making the process time-consuming.

On the new product, the regenerative resistor is directly connected to an internal board, improving productivity and design quality.



(a) SANMOTION R (Current product)　(b) SANMOTION G (New product)

Fig. 14 Built-in regenerative resistor wiring

6.4.2 Enhanced inspection with automation

Conventionally, LED lighting was inspected visually, and switch functionality was verified manually.

We have now introduced a new optical inspection system. LED inspections are performed by a camera that checks the lighting and automatically evaluates pass/fail status. For switch inspections, a camera detects the switch coordinates, and a robot performs the actuation. These automated inspection processes enhance inspection consistency and overall quality.

7. Conclusion

This article provided an overview of the *SANMOTION G* 48 VDC servo system and introduced its key features and development highlights, designed around the concepts of "powerful" and "user-friendly."

In comparison with the current model, the *SANMOTION G* offers the following enhancements.

(1) The current lineup offers products with a rated output ranging from 30 to 200 W, while the new lineup adds a 400 W model, enabling use in higher-output and larger equipment.

(2) Peak torque density improved by up to 39%, and the output range in the high-speed area expanded 1.36 times. By increasing the encoder resolution by 16 times (up to 27 bit) and the velocity loop frequency response by 2.2 times (to 1.5 kHz), stable, highly-responsive operation has been achieved.

(3) Vibration resistance has been doubled on the servo motor (from 24.5 m/s^2 to 50 m/s^2) and improved by 1.2 times on the servo amplifier (from 4.9 m/s^2 to 6.0 m/s^2). The operating altitude was increased from 1,000 m to 2,000 m, and the upper limit of the ambient temperature increased from 40°C to 60°C—a 1.5 times improvement. These enhancement allow the product to be used in various regions, even in harsh environments.

(4) We made the servo motor smaller and lighter by reducing the length and weight by up to 19% and 32%, respectively. With the servo amplifier, we realized energy savings by reducing the mass and energy loss by up to 9% and 12.8%, respectively.

(5) The motor power and holding brake cable have been integrated, and the connector orientation can be changed. This has increased the wiring flexibility, making wiring work easier.

(6) The servo motor and servo amplifier maintain the same external dimensions and mounting dimensions as the current model, simplifying installation. Horizontal mounting capability has also been added for the servo amplifier, helping customers reduce overall equipment height.

The *SANMOTION G* 48 VDC servo system features significantly improved servo performance and higher reliability, ensuring reliable use even in harsh environments. Through reductions in energy consumption, size, and weight, the product is friendly to both the environment and users.

Going forward, we will continue to develop environmentally friendly, compact, lightweight, highly efficient, low-noise products that are optimized for our customers' equipment.

(1) Current products are as follows.
Servo motors: SANMOTION R series
Servo amplifiers: SANMOTION R series (RS2K)
(2) The company names and product names listed in this article are the trademarks or registered trademarks of their respective owners.
(3) Patent application being processed.

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