

SANYO DENKI

Technical Report

Feature | Technical Developments in 2025



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SANYO DENKI PHILIPPINES, INC.



COLUMN

Cover image:

SANYO DENKI PHILIPPINES, INC.

2000

SANYO DENKI PHILIPPINES, INC. was established in February 2000 in the Subic Bay Freeport Zone to support the SANYO DENKI Group's global business expansion. The company manufactures products that meet the demands of international markets while maintaining and advancing its proprietary technologies and the trust of its customers.

Since its establishment, the company has earned international certifications and developed a production system that delivers high-quality products with reduced environmental impact. In 2019, it expanded its capabilities by opening a Technology Center to advance manufacturing technologies, develop new products, and enhance testing and evaluation functions. As a result, it has evolved from a manufacturing base into a hub for both production and technology development.

The company has also contributed to the local economy through job creation and workforce development. Comprehensive training programs have established a sustainable foundation for manufacturing and product development. Today, as one of the Group's principal production sites, the company helps diversify manufacturing risk and ensure the timely supply of products to customers throughout Asia and around the world. It also supports the Group's competitiveness in growth markets, including renewable energy.

Leveraging the advanced infrastructure of the Subic Bay Freeport Zone, the company manufactures many of the products sold under the Group's core brands, including cooling fans, servo motors, and UPSs. These products support a wide range of applications, including IT equipment, telecommunications base stations, industrial robots, medical and inspection equipment, and renewable energy systems, underpinning the Group's global competitiveness. Guided by its commitment to "continue to develop world-leading products in terms of quality, performance, and reliability," we will continue to play an increasingly important role in the years ahead.

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SANYO DENKI Technologies and the Future

Yasutaka Narusawa Operating Officer

At SANYO DENKI, we address a wide range of social challenges and market needs through products and technologies that support industrial and social advancement. One of the most significant recent trends is the rapid global expansion of data center investment driven by the growing adoption of generative AI. Operating these facilities, however, requires enormous amounts of power and resources.

At the same time, declining birthrates and shrinking labor populations in Japan and many other countries are accelerating demand for AI, robotics, and automation technologies that reduce workloads and improve productivity. To help address these challenges and build a more sustainable future, we are advancing energy and resource efficiency while promoting automation and digitalization through our products and services.

Our core products—including cooling fans, servo motors, and uninterruptible power supplies (UPSs)—are all energy conversion devices that play a vital role in improving energy and resource efficiency. For this reason, we continue to pursue the fundamental requirements of energy conversion technology: high efficiency, compact and lightweight design, and low noise.

Servo systems, including servo motors and servo amplifiers have long supported factory automation in machine tools and industrial robots. In recent years, their applications have expanded into new fields such as agricultural automation and nursing care robotics, driven by labor shortages. We are actively developing products optimized for these emerging applications.

We are also expanding our engineering support services by combining the design and manufacturing expertise cultivated over many years with the latest digital technologies. For example, our CFD Simulation Service leverages cooling fan design expertise to optimize airflow and select appropriate cooling fans before equipment is built. Our Production Engineering Service supports automation and operational efficiency at manufacturing sites.

Through these technologies and services, we continue helping solve customer and societal challenges and shaping the future.

This issue highlights the major products and technologies released in fiscal 2025 as part of our “Technical Developments in 2025.”

For the San Ace product line, we developed high-performance, low-power large fans and Counter Rotating Fans. These products significantly reduce power consumption while delivering excellent cooling performance, making them ideal for high-heat-density applications such as AI servers and data centers. We also expanded the lineup with ACDC Fans and Long Life Fans that combine high cooling performance with high reliability. These products are well suited for applications requiring continuous operation, including control panels, FA equipment, and ICT equipment.

For the SANUPS product line, we developed the *SANUPS NIID*, which features high overload capability, high efficiency, and low noise. It is particularly well suited for applications with large power fluctuations, such as commercial elevators and other motor-driven systems. To provide optimal backup solutions for a wide range of applications, the lineup includes lead-acid battery, lithium-ion battery, and EDLC⁽¹⁾ models. We also added a low-noise model to the hybrid UPS *SANUPS EIIB* series. Its quiet operation makes it suitable for noise-sensitive environments such as offices and medical facilities.

For the SANMOTION product line, we added 48 VDC servo motors and servo amplifiers to the *SANMOTION G* series. These products are ideal for battery-powered applications such as AMRs⁽²⁾ and agricultural automation robots. We also developed the *SANMOTION C S300* Motion Controller, which combines high performance, scalability, and enhanced security features. In addition to delivering highly precise motion control and extensive functionality, it provides strong protection against unauthorized external access.

Next year, SANYO DENKI will celebrate its 100th anniversary. Although society and lifestyles have changed dramatically over the past century, our commitment to our corporate philosophy remains unchanged: “We at SANYO DENKI Group Companies aim to help all people achieve happiness, and work with people to make their dreams come true.” Guided by this philosophy, we will continue creating the future together with our customers and society.

(1) EDLC (Electric Double Layer Capacitor): A high-capacity, fast-charging capacitor.

(2) AMR (Autonomous Mobile Robot): A self-navigating mobile robot.

San Ace Products

Yo Muramatsu

Investment in digital technologies, particularly generative AI, is driving a new growth phase in infrastructure markets that support society and industry.

In 2025, practical adoption of generative AI accelerated, driving global expansion in data center investment centered on high-performance GPU servers. As a result, demand for ICT equipment continues to increase in both scale and sophistication. These trends are driving higher component density and increased power

consumption, making advanced thermal management more critical than ever.

At the same time, the widespread adoption of cloud services and remote work requires the continuous, stable operation of communications infrastructure, increasing demand for highly reliable, long life cooling fans. Furthermore, the expansion of renewable energy systems and DC fast chargers, driven by decarbonization efforts, is increasing demand for cooling fans that combine energy efficiency with high

environmental durability.

To meet increasingly diverse application, installation conditions, and performance requirements, we have focused on developing cooling fans that provide high cooling performance, low power consumption, and long service life.

The following section introduces the lineup and key features of cooling fans developed and released in 2025 to address these market needs.

■ 92 × 92 × 25 mm ACDC Fan

ACDC Fan

• 92 × 92 × 25 mm *San Ace 92AD 9AD* type

The *San Ace 92AD* ACDC Fan delivers both cooling performance and energy efficiency, a balance difficult to achieve with conventional AC fans. While maintaining industry-leading⁽¹⁾ airflow and static pressure, it reduces power consumption by up to 81% compared with our conventional AC fan models under equivalent performance conditions. It also delivers

an expected service life of 60,000 hours at 60°C, approximately 2.4 times longer than the conventional AC fan models. This enables highly reliable, energy-efficient, high-performance cooling for continuous-operation applications such as server racks and control panels..

Its details are covered in a separate article in this issue.



(1) Based on our own research as of May 26, 2025, conducted among equally sized axial ACDC fans on the market.

■ Long Life Fan

DC Fan

• 80 × 80 × 38 mm *San Ace 80L* 9LG type

The *San Ace 80L* Long Life Fan delivers industry-leading⁽²⁾ static pressure and high reliability. It achieves an expected service life of 100,000 hours at 60°C, while delivering maximum airflow of 3.42 m³/min and maximum static pressure of 1,260 Pa. It supports 12/24/48 VDC input and PWM control, enabling optimization based on equipment requirements. In addition, it reduces power consumption

by 32% compared with two of the conventional 80 × 80 × 25 mm fans connected in series under equivalent cooling performance conditions. This enables low power consumption and high reliability in continuous-operation applications such as factory automation equipment, measuring instruments, and ICT equipment.

Its details are covered in a separate article in this issue.



(2) Based on our own research as of June 30, 2025, conducted among equally sized axial DC fans on the market.

■ High-Performance Fan

DC Fan

• ø200 × 70 mm *San Ace 200* 9GA type

The *San Ace 200* 9GA type DC Fan delivers lower power consumption while maintaining high cooling performance. In server racks for data centers and heat exchangers for liquid cooling systems, increasing heat generation is driving demand for higher airflow and static pressure. Meanwhile, reducing power consumption has become increasingly important for lowering operating costs and addressing environmental concerns. The fan delivers maximum airflow of 30.7 m³/min and maximum static

pressure of 1,350 Pa, while reducing power consumption by approximately 15% compared with our conventional ø200 × 70 mm fans under equivalent performance conditions. These improvements were achieved through optimization of motor efficiency and aerodynamic efficiency, delivering industry-leading⁽³⁾ efficiency in its class. It supports 48 VDC input and features PWM control and a pulse sensor, providing low-power, highly reliable cooling for data center applications.



(3) Based on our own research as of March 25, 2025, conducted among equally sized axial DC fans on the market.

- 80 × 80 × 80 mm *San Ace 80 9CRHA* type Counter Rotating Fan

The *San Ace 80 9CRHA* type High Static Pressure Counter Rotating Fan delivers industry-leading⁽⁴⁾ cooling performance, with maximum airflow of 5.65 m³/min and maximum static pressure of 2,700 Pa. It is available in 12 and 48 VDC models and supports PWM control and a pulse sensor. It achieves an expected service life of 40,000 hours at 60°C while providing stable operation under the high-static-pressure conditions required to

handle the increase in heat generated by GPU servers for generative AI applications. At the operating point (approximately 2.7 m³/min), it reduces power consumption by up to 21% compared with our conventional 80 × 80 × 80 mm Counter Rotating Fans under equivalent performance conditions. This enables low power consumption and high reliability in demanding thermal designs for high-density servers, including GPU servers.



(4) Based on our own research as of May 26, 2025, conducted among equally sized axial DC fans on the market.

Author

Yo Muramatsu

Design Dept., San Ace Company

Works on the design and development of cooling fans.

92 × 92 × 25 mm *San Ace 92AD* 9AD Type ACDC Fan

Masashi Murakami

Soma Araki

Toranosuke Hirata

Naoki Murakami

1. Introduction

In recent years, reducing power consumption has become increasingly important due to energy and environmental concerns, increasing demand for AC cooling fans with lower power consumption and longer service life. Demand is also increasing for PWM control that adjusts fan speed according to equipment operating conditions, as well as wide-range input voltage support for global markets.

In addition, as control panels and industrial equipment become more compact and multifunctional, internal space is becoming more limited, increasing demand for smaller cooling fans. Customers using our conventional AC fans have also requested dimensional compatibility that eliminates the need for equipment redesign during replacement.

To address these needs, we developed the 92 × 92 × 25 mm *San Ace 92AD* 9AD type ACDC Fan (hereinafter, “new product”), featuring a built-in AC-DC conversion circuit that maintains consistent performance regardless of input voltage. At 92 mm square, it is the smallest ACDC fan in our lineup, and is available in a wide range of speed options to support diverse customer requirements. This article introduces the performance, features, and key design features of the new product.

2. Product Features

Figure 1 shows the new product. The new product is the smallest ACDC fan in our lineup.

Key features are as follows.

- (1) Low power consumption
- (2) Long service life
- (3) Wide operating temperature range
- (4) High static pressure and high airflow
- (5) PWM-based fan speed control



Fig. 1 92 × 92 × 25 mm *San Ace 92AD*
9AD type ACDC Fan

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 our 92 × 92 × 25 mm *San Ace 92* AC Fan (hereinafter, “conventional product”).

3.2 Specifications

3.2.1 General specifications

Table 1 shows the general specifications of the new product. Five models are available: one maximum-speed model with PWM control, and four fixed-speed models—maximum-speed, high-speed, medium-speed, and low-speed. With an operating voltage range of 90 to 264 VAC, making them compatible with both 100 and 200 VAC systems.

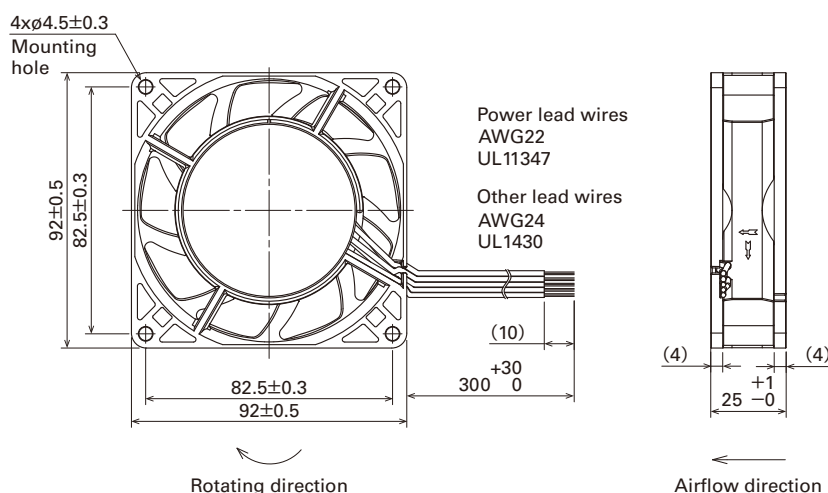


Fig. 2 Dimensions of 92 × 92 × 25 mm *San Ace 92AD 9AD* type ACDC Fan (Unit: mm)

Table 1 General specifications of 92 × 92 × 25 mm *San Ace 92AD 9AD* type ACDC Fan

Model no.	Rated voltage [V]	Operating voltage range [V]	Frequency [Hz]	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]
								[m³/min]	[CFM]	[Pa]	[inchH ₂ O]			
9AD0901G4002	100 to 240	90 to 264	50/60	—	0.06	3.2	3850	1.34	47.3	76	0.305	43	-20 to +70	60000 at 60°C (90000 at 40°C)
9AD0901H4002				—	0.04	2.3	3200	1.1	38.8	52	0.208	38		
9AD0901M4002				—	0.03	1.7	2800	0.97	34.2	40	0.160	34		
9AD0901L4002				—	0.02	1.1	1900	0.64	22.6	19	0.076	24		
9AD0901P4G001				100	0.06	3.2	3850	1.34	47.3	76	0.305	43		
				30	0.02	0.7	1200	0.42	14.8	8.6	0.034	13		

* PWM input frequency is 25 kHz. Fan speed is 0 min⁻¹ at 0% PWM duty cycle. Expected service life at an ambient temperature of 40°C is provided for reference only.

3.2.2 Airflow vs. static pressure characteristics

Figure 3 shows the airflow vs. static pressure characteristics for the maximum-speed model with PWM control, 9AD0901P4G001. Figure 4 shows the airflow vs. static pressure characteristics for the maximum-speed model 9AD0901G4002, high-speed model 9AD0901H4002, medium-speed model 9AD0901M4002, and low-speed model 9AD0901L4002. All new models provide identical airflow vs. static pressure characteristics across an input voltage range of 100 to 240 VAC.

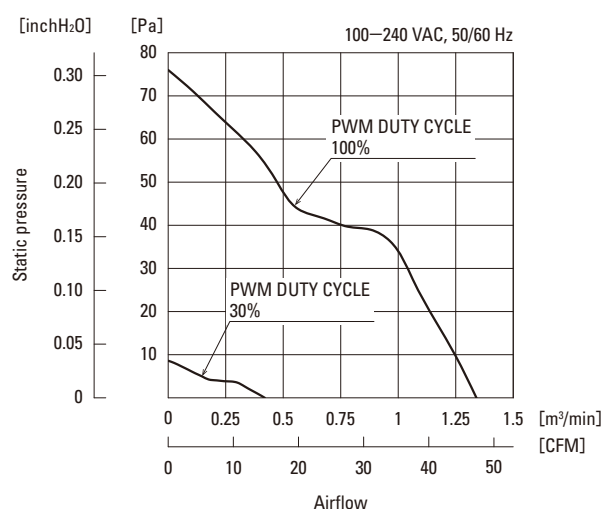


Fig. 3 Airflow vs. static pressure characteristics of 9AD0901P4G001

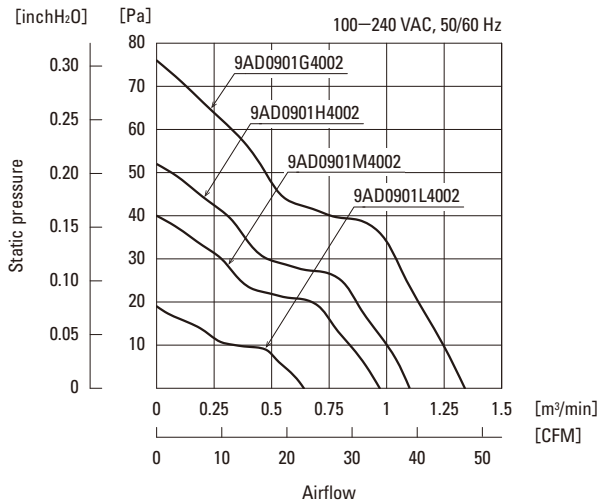


Fig. 4 Airflow vs. static pressure characteristics of 9AD0901G4002, 9AD0901H4002, 9AD0901M4002, and 9AD0901L4002 models

3.2.3 PWM control

The 9AD0901P4G001 model comes with PWM control for controlling the fan speed.

3.3 Expected life

The new product has an expected life of 60,000 hours at 60°C (survival rate of 90%, continuous operation at rated voltage under free-air, non-condensing conditions).

4. Technical Highlights

The new product achieves lower power consumption, longer service life, higher static pressure, and higher airflow while maintaining the same size as our conventional AC Fan. The main technical highlights are summarized below.

4.1 High airflow and high static pressure

Because the new product incorporates large components required for the AC-DC conversion circuit—such as capacitors and reactors—inside the fan, the diameter of the center hub is necessarily larger. Given the compact 92 mm frame size, the limited space between the outer diameter of the blade hub and the inner diameter of the frame constrained blade profile design, which had hindered performance improvements.

Although these constraints significantly shorten the blade length, the new product achieves industry-leading airflow and static pressure through an optimized blade design that delivers high performance even with shorter blades. Figure 5 shows the impeller geometry of the new product.



Fig. 5 Impeller geometry of the new product

4.2 Low power consumption and long service life

The new product internally converts AC power into DC power to drive a DC motor, improving motor efficiency and reducing losses compared with AC motors. Highly efficient blade and frame designs suppress temperature rise in the motor and bearings, enabling significantly higher airflow and static pressure than conventional AC fans while also reducing power consumption and extending service life.

Power consumption was reduced by 68%, from 10 W for the conventional product to 3.2 W for the new product.

The expected life (at 60°C, survival rate of 90%, continuous operation at rated voltage under free-air, non-condensing conditions) is 60,000 hours, which is 2.4 times longer than the 25,000-hour life of the conventional product.

5. Comparison of New and Conventional Products

5.1 Comparison of airflow vs. static pressure characteristics

Figure 6 compares the airflow vs. static pressure characteristics of the new and conventional products. Compared to the conventional product, the maximum airflow and maximum static pressure of the new product have improved by 20% and 50%, respectively.

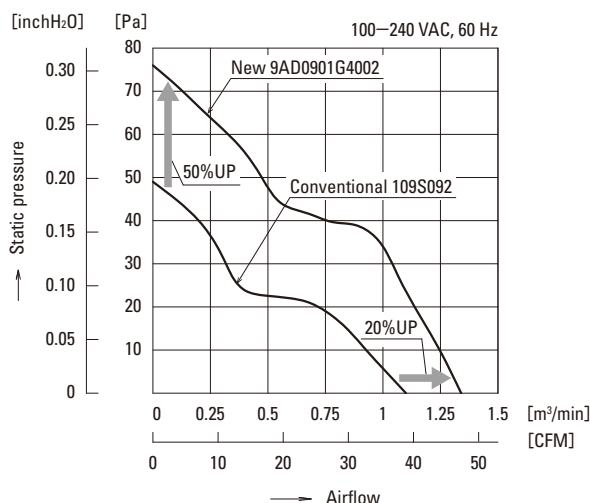


Fig. 6 Airflow vs. static pressure characteristics of the new and conventional products

5.2 Power consumption comparison with the conventional product at equivalent performance

Figure 7 compares power consumption for the new and conventional products at equivalent cooling performance. The results show that, when the fan speed of the new product is reduced through PWM control to match the cooling performance of the conventional product, power consumption at the operating point was reduced by 81%.

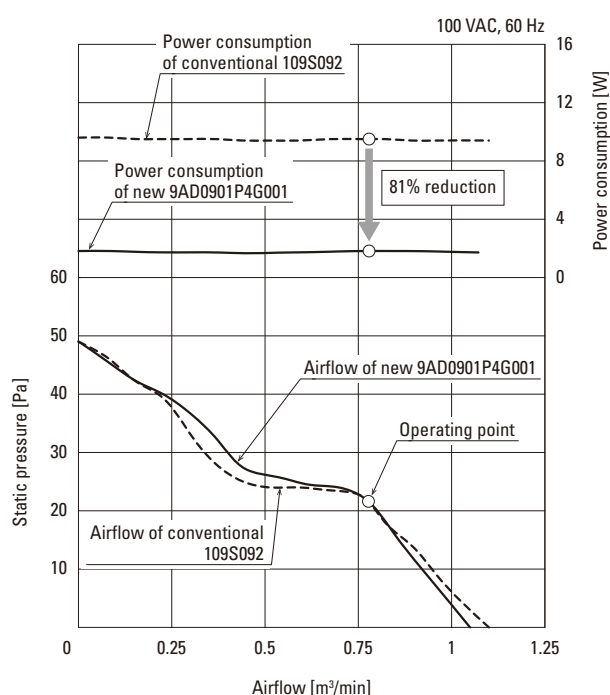


Fig. 7 Airflow vs. power consumption characteristics of the new and conventional products (60 Hz)

5.3 Environmental impact comparison

Figure 8 compares the CO₂ emissions of the new and conventional products over their life cycles. Thanks to its significantly lower power consumption, the new product generates 81% less CO₂ over its lifecycle than the conventional product, qualifying it for Eco Products Plus certification.

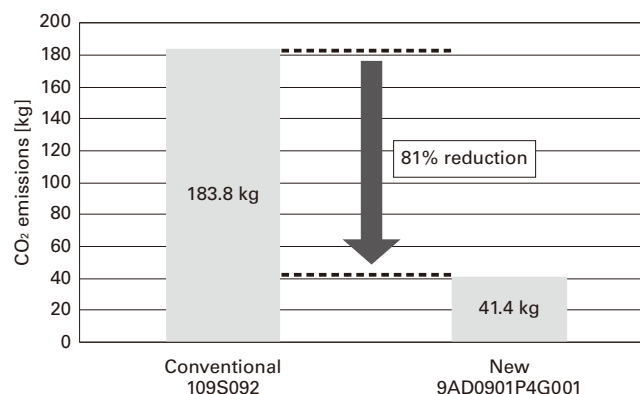


Fig. 8 CO₂ emissions comparison using our LCA calculation software (25,000-hour continuous operation in free air)

6. Conclusion

This article presented the features and performance of the newly developed 92 × 92 × 25 mm *San Ace 92AD* 9AD type ACDC Fan. The new product has a built-in AC-DC conversion circuit and its impeller, frame shape, motor, and circuit are designed for high efficiency. This enables higher airflow, higher static pressure, lower power consumption, longer service life, PWM control, and a wider input voltage range than conventional AC fans.

Reducing power consumption is an increasingly important societal issue, and demand for lower power consumption and longer service life in cooling fans is expected to continue growing.

We will continue to develop products that meet evolving market needs.

Author

Masashi Murakami

Design Dept., San Ace Company

Works on the development and design of cooling fans.

Soma Araki

Design Dept., San Ace Company

Works on the development and design of cooling fans.

Toranosuke Hirata

Design Dept., San Ace Company

Works on the development and design of cooling fans.

Naoki Murakami

Design Dept., San Ace Company

Works on the development and design of cooling fans.

80 × 80 × 38 mm *San Ace 80L* 9LG Type Long Life Fan

Yen Junchieh Yukihiro Nagatsuka Louis Chen Eva Liu Toshiyuki Nakamura

1. Introduction

In recent years, equipment used in factory automation (FA), measuring instruments, and telecommunications systems has required not only high cooling performance but also long service life, and demand for such products continues to grow.

SANYO DENKI has been developing Long Life Fans in various sizes for different applications. To expand this lineup, we newly developed the 80 × 80 × 38 mm *San Ace 80L* 9LG Type Long Life Fan (hereinafter, “new product”), a size not previously available in our range.

The new product offers a long expected life across a wide range of applications. Optimized for applications such as machine tools and telecommunications equipment, it is available in multiple voltage specifications, providing greater flexibility in equipment design.

This article will introduce the features and performance of the new product.

2. Product Features

Figure 1 shows the new product. The new product is a Long Life Fan in a new size not previously available in the existing lineup.

Its product features are as follows

- (1) High airflow and high static pressure
- (2) Long service life
- (3) Low power consumption

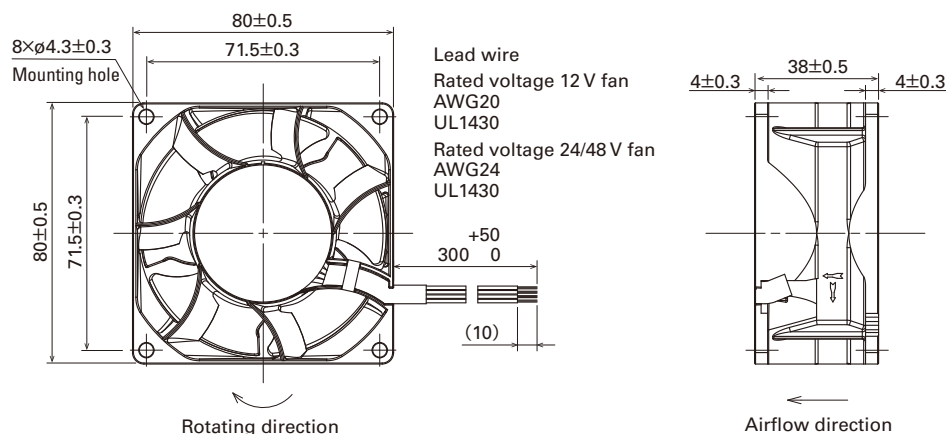


Fig. 1 80 × 80 × 38 mm *San Ace 80L* 9LG type

3. Product Overview

3.1 Dimensions

Figure 2 shows the dimensions of the new product. The frame size and mounting hole dimensions are compatible with our 80 × 80 × 25 mm *San Ace 80L* 9LG Type Fan (hereinafter, “conventional product”).

Fig. 2 Dimensions of 80 × 80 × 38 mm *San Ace 80L 9LG* type (Unit: mm)Table 1 General specifications of 80 × 80 × 38 mm *San Ace 80L 9LG* 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]				
							[m³/min]	[CFM]	[Pa]	[inchH₂O]							
9LG0812P1G001	12	10.8 to 13.2	100	2.8	33.6	15200	3.42	120	1260	5.04	71	-20 to +70	100000 at 60°C (135000 at 40°C)				
9LG0812P1H001			20	0.13	1.56	3600	0.84	29.6	73.3	0.293	42						
			100	1.8	21.6	12700	2.86	101	880	3.52	68						
			20	0.13	1.56	3600	0.84	29.6	73.3	0.293	42						
9LG0824P1G001	24	21.6 to 26.4	100	1.4	33.6	15200	3.42	120	1260	5.04	71			-20 to +70	100000 at 60°C (135000 at 40°C)		
9LG0824P1H001			20	0.09	2.16	3600	0.84	29.6	73.3	0.293	42						
			100	0.90	21.6	12700	2.86	101	880	3.52	68						
			20	0.09	2.16	3600	0.84	29.6	73.3	0.293	42						
9LG0848P1G001	48	36 to 60	100	0.70	33.6	15200	3.42	120	1260	5.04	71					-20 to +70	100000 at 60°C (135000 at 40°C)
9LG0848P1H001			20	0.08	3.84	3600	0.84	29.6	73.3	0.293	42						
			100	0.45	21.6	12700	2.86	101	880	3.52	68						
			20	0.08	3.84	3600	0.84	29.6	73.3	0.293	42						

* 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 Specifications

3.2.1 General specifications

Table 1 shows the general specifications of the new product. To support a wide range of applications, the product lineup includes models with three rated voltages—12, 24, and 48 VDC—and two speed options: high and low.

3.2.2 Airflow vs. static pressure characteristics

Figure 3 shows the airflow vs. static pressure characteristics of the new product. The 12, 24, and 48 V models all have identical characteristics.

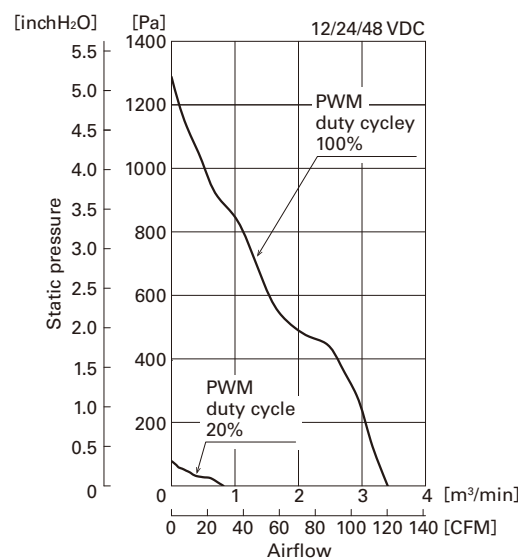


Fig. 3 Airflow vs. static pressure characteristics of 9LG0812P1G001

3.2.3 PWM control

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

3.3 Expected life

The new product has an expected life of 100,000 hours at 60°C (survival rate of 90%, continuous operation at rated voltage under free-air, non-condensing conditions).

4. Technical Highlights

To achieve high airflow, high static pressure, and long service life, the new product incorporates newly designed blades, frame, motor, and circuitry. This enables offering a high-performance cooling fan that meets market requirements. The main technical highlights are summarized below.

4.1 Motor and circuit design

To achieve both high airflow and high static pressure performance and long service life, a newly designed high-efficiency 3-phase motor was designed, resulting in higher speeds and lower power consumption. For the drive circuit, the use of high-performance and high-reliability electronic components suppresses heat generation, enabling both high cooling performance and long service life.

4.2 Impeller and frame design

The blade and frame geometries were optimized through repeated simulations and prototype evaluations to achieve a balance between high airflow and high static pressure. Figure 4 shows an example of airflow visualization obtained from simulation. In addition, an aluminum frame was adopted to improve both mechanical strength and thermal dissipation, enabling an expected service life of 100,000 hours.

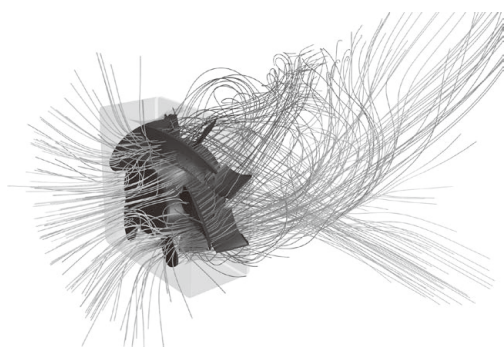


Fig. 4 Simulation example

5. Comparison of New and Conventional Products

5.1 Comparison of airflow vs. static pressure characteristics

Figure 5 compares the airflow vs. static pressure characteristics of the new and conventional products. Compared with the conventional product, the new product achieves approximately 1.65 times higher maximum airflow and approximately 7.12 times higher maximum static pressure.

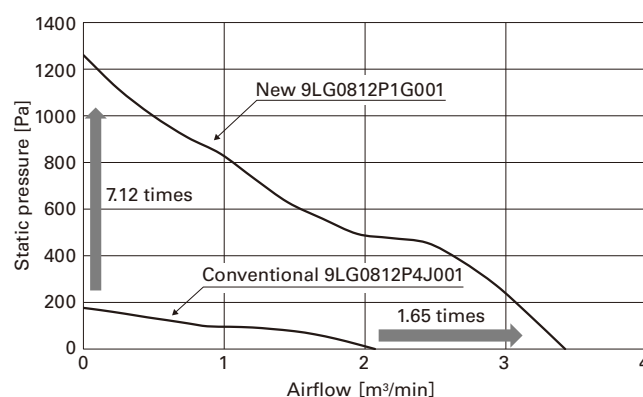


Fig. 5 Airflow vs. static pressure characteristics of the new and conventional products

5.2 Power consumption comparison with the conventional product at equivalent performance

Figure 6 compares power consumption for the conventional and new products at equivalent cooling performance. For the conventional product, performance is based on two units connected in series. The new product reduces power consumption by approximately 32% compared with the conventional configuration.

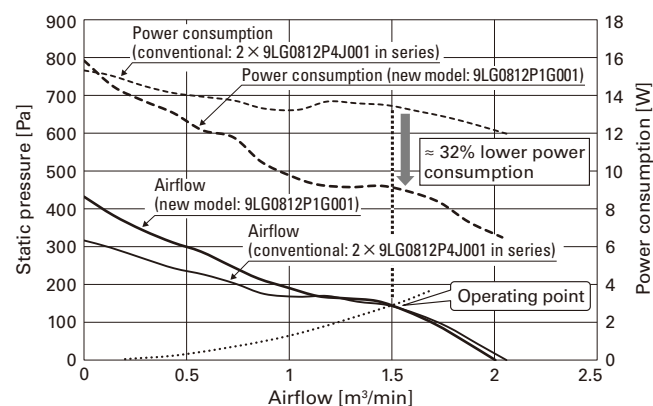


Fig. 6 Airflow vs. power consumption characteristics of the new and conventional products

5.3 Environmental impact comparison

Figure 7 compares the CO₂ emissions of the new and conventional products over their life cycles. By reducing power consumption, the new product achieves a 32% reduction in CO₂ emissions over its lifecycle compared with the conventional product.

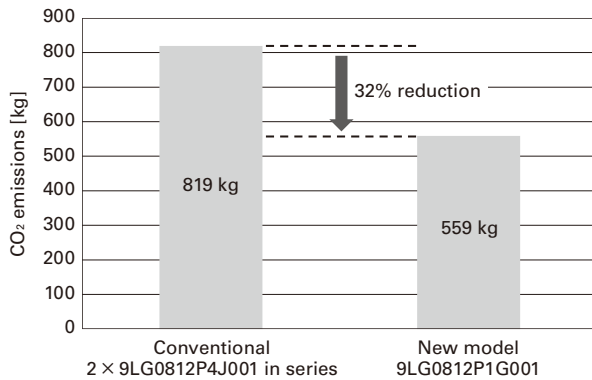


Fig. 7 CO₂ emissions comparison using our LCA calculation software (100,000 hours at equivalent operating airflow; two conventional fans connected in series)

6. Conclusion

This article has presented the features and performance of the 80 × 80 × 38 mm *San Ace 80L 9LG* Type Long Life Fan.

Compared with the conventional product, the new product delivers higher performance while maintaining a long service life, helping reduce maintenance requirements for customer equipment. By reducing power consumption while maintaining high cooling performance, the product also contributes to energy savings and lower environmental impact.

In addition, the new product supports a wide range of applications and helps improve the performance and reliability of various types of equipment. We hope the product further strengthen our customers' competitiveness in the market.

Author

Yen Junchieh

Design Dept., SANYO DENKI TAIWAN CO. LTD
Works on the development and design of cooling fans.

Yukihiro Nagatsuka

Design Dept., SANYO DENKI TAIWAN CO. LTD
Works on the development and design of cooling fans.

Louis Chen

Design Dept., SANYO DENKI TAIWAN CO. LTD
Works on the development and design of cooling fans.

Eva Liu

Design Dept., SANYO DENKI TAIWAN CO. LTD
Works on the development and design of cooling fans.

Toshiyuki Nakamura

Design Dept., San Ace Company
Works on the development and design of cooling fans.

SANUPS Products

Tsuyoshi Kobayashi

SANUPS products provide highly reliable power through energy conversion systems such as uninterruptible power supplies (UPSs), renewable energy inverters, and engine generators, contributing to operational reliability and a more sustainable society. This article presents two SANUPS products developed in 2025.

The first product is the *SANUPS N11D*, featuring 200% overload capability and flexible installation options.

This product supports up to 200% of the rated load during power outages, making it suitable as a backup power source for applications with large power fluctuations, such as motor-driven equipment and freight elevators. It reduces the risk of power interruption and supports

stable operation.

Supporting wall-mounted, floor-standing, and rack-mounted configurations, the product can be installed in limited spaces such as control panels and equipment enclosures.

The *SANUPS N11D* provides reliable backup power across a wide range of applications.

Next, we present the *SANUPS E11B*, designed for low-noise operation.

To increase the maximum ambient operating temperature from 40°C to 55°C, the *SANUPS E11B* uses high-speed cooling fans that improve cooling performance, enabling operation in a wider range of environments. However, fan noise can be noticeable in quiet environments.

To address this issue, fan speed is optimally controlled according to operating conditions such as the operation mode and ambient temperature, maintaining high efficiency and energy-saving performance while reducing noise levels by more than 20% compared with conventional models.

The expanded low-noise lineup of the *SANUPS E11B* is suitable for quiet environments such as offices and medical facilities.

Below are some of the features of these new products and their contribution to customers and society.

■ The *SANUPS N11D* with 200% Overload Capability and Flexible Installation

In recent years, UPSs have been increasingly used as backup power sources not only for IT equipment such as PCs and servers, but also for motor-driven equipment including industrial robots and freight elevators.

Because such equipment requires high startup power, the conventional 110% overload capability often required the use of higher-capacity UPS units. In addition, demand has increased for installation in limited spaces such as control panels and inside equipment. To address these requirements, we developed the *SANUPS N11D*, featuring 200% overload capability and flexible installation options.

The product has the following four features.

1. 200% overload capability

The UPS supports up to 200% of its rated capacity, enabling stable operation of equipment with large power fluctuations, such as freight elevators, industrial robots, and motor-driven equipment.

2. High efficiency and energy savings

The UPS achieves up to 98.6% conversion efficiency, reducing power consumption and CO₂ emissions and contributing to sustainability goals.

3. Low noise

The noise level is 40 dB or less, allowing installation in noise-sensitive environments.

4. Flexible lineup and installation options

Its slim design supports both wall-mounted installation, as shown in Figure 1, and floor-standing installation, as shown in Figure 2, enabling installation inside control panels and equipment enclosures.

The lineup also includes models with lead-acid batteries, lithium-ion batteries, and electric double-layer capacitors (EDLCs), allowing selection based on application and operating conditions. Each model has features as follows.

- **Lead-acid battery model:**

Lowest initial cost

- **Lithium-ion battery model:**

Lightweight, long life, wide operating temperature range

- **EDLC model:**

Suitable for voltage sag compensation; supports energy savings through regenerative energy utilization

The *SANUPS N11D* provides stable power supply for equipment with large power fluctuations, and offers a versatile lineup suitable for a wide range of installation environments.

Details on this product are covered in a separate article in this issue.



Fig. 1 Wall-mounted



Fig. 2 Floor-standing

■ Expansion of Low-Noise Lineup for the *SANUPS E11B*

UPSs are often used in quiet environments such as offices and medical facilities, where low-noise operation is required to maintain a comfortable environment.

For the hybrid UPS *SANUPS E11B*, the maximum ambient operating temperature has been increased from 40°C to 55°C, which is approximately 1.3 times that of the current model.

To enable operation in high-temperature environments, high-speed cooling fans were adopted to improve cooling performance. However, in quiet environments such as offices and medical facilities, cooling fan noise may become noticeable. To address this issue, nine quiet-operation models with excellent low-noise performance have been added to the lineup, including 1 kVA 100/200 V models and 1.5 kVA 100 V models, including UL-certified models.

The product is shown in Figures 3 and 4.

In these models, fan speed is optimally controlled according to the operation mode, load level, and ambient temperature, ensuring effective cooling while significantly reducing noise levels.

While maintaining the same high efficiency and energy-saving performance as the current models, noise levels have been reduced by more than 20% under ambient temperatures of 40°C or lower.

The expanded low-noise lineup of the *SANUPS E11B* enables comfortable use even in noise-sensitive environments such as offices and medical facilities.



Fig. 3 *SANUPS E11B* (Front view)

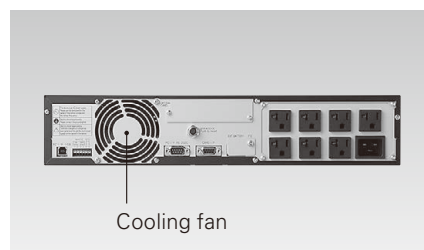


Fig. 4 *SANUPS E11B* (Rear view)

Author

Tsuyoshi Kobayashi

Design Dept., Electronics Company

Works on the development and design of power supply units, monitoring devices, and Servo Systems products.

Development of the Standby UPS *SANUPS N11D*

Yuto Iwasaki Satoshi Furihata Yoshitsugu Kashiwagi Kazuya Nishizawa Nobuya Otsuki
 Hiroyuki Hanaoka Kazuya Kudo Shota Ozawa Mai Saito

1. Introduction

In recent years, uninterruptible power supplies (UPSs) have expanded beyond IT equipment such as PCs and servers into industrial applications, including motor-driven equipment such as industrial robots, freight elevators, and semiconductor manufacturing equipment.

Compared with steady-state operation, motor-driven equipment requires significantly higher power during startup. As a result, conventional systems often required oversized UPSs with excess rated capacity to accommodate these temporary peak loads.

In many industrial applications, UPSs are also installed inside control panels or equipment enclosures where installation space is limited, making installation flexibility another important requirement.

To address these challenges, SANYO DENKI developed the Standby UPS *SANUPS N11D*. This product provides high installation flexibility and high overload capability, enabling reliable support for equipment with high startup power demands, such as motor-driven systems.

This paper first outlines the product, followed by its key features and development highlights.

2. Product Overview

Figure 1 shows the *SANUPS N11D*. Its slim design allows wall mounting and easy installation inside control panels and equipment. The UPS and battery unit can also be installed separately.

Figure 2 shows the circuit diagram for the *SANUPS N11D*. The product uses a standby topology. During normal operation, utility power is supplied directly to the load while the battery is charged through a bidirectional inverter. During a power outage, the inverter converts battery's DC power to AC power and supplies it to the load.

Table 1 lists the electrical specifications. The product is available in 2 kVA and 3 kVA single-phase, 2-wire models.

Three energy storage options are available: lead-acid batteries, lithium-ion batteries, and electric double-layer capacitors (EDLCs).

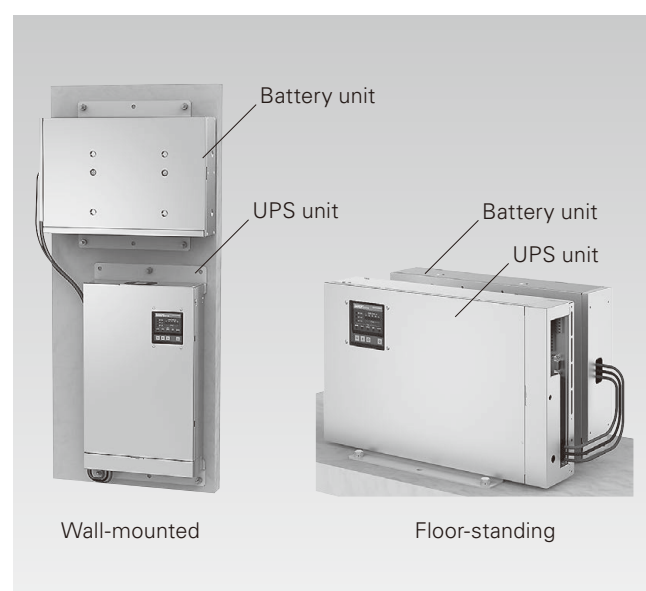


Fig. 1 The *SANUPS N11D*

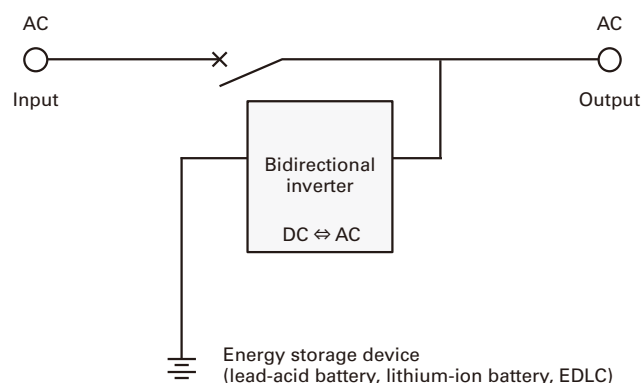


Fig. 2 Circuit diagram for the *SANUPS N11D*

Table 1 Electrical specifications of the *SANUPS N11D*

		SANUPS N11D		SANUPS N11D-Li		SANUPS N11D-C	
Energy storage device		Lead-acid battery		Lithium-ion battery		EDLC	
Rated output capacity		2 kVA	3 kVA	2 kVA	3 kVA	2 kVA	3 kVA
Rated load power factor		0.8					
Topology		Standby					
No. of phases/wires		Single-phase 2-wire					
AC input	Rated voltage	200/208/220/230 V					
	Voltage range	-15% to +10% / -8% to +8%					
	Rated frequency	50/60 Hz					
	Frequency range	± 3, ± 5, ± 7%					
	Required input capacity	2.2 kVA or less	3.3 kVA or less	2.7 kVA or less	3.7 kVA or less	3.0 kVA or less	4.0 kVA or less
AC output (Grid operation)	Rated voltage	Input voltage +0 V/-4 V					
	Rated frequency	Depends on input frequency					
AC output (Backup operation)	Rated voltage	200/208/220/230 V					
	Voltage range	Within ± 3%					
	Rated frequency	50/60 Hz					
	Frequency range	Within ± 0.5%					
	Voltage harmonic distortion	Linear load: 5% or less Rectifier load: 10% or less					
	Transient voltage fluctuation	Within ± 10% (for 0 ⇔ 100% load step change)					
	Operation transfer time ⁽¹⁾	10 ms or less					
Overload capability	In grid operation	150% (for 60s), 200% (for 30s), 800% (for 2 cycles)					
	In backup operation	150% (for 60s), 180% (for 10s), 200% (for 1s)				150% (for 0.5s), 200% (for 0.2s)	
Backup time ⁽²⁾		5 min, 9 min	5 min	9 min	8 min	2.8s	1.5s
Acoustic noise	In grid operation	40 dB or less					
	In backup operation	60 dB or less					
Maximum regenerative energy (Backup operation)		—				2.4 kW _s	
Input leakage current		3.5 mA or less					
Operating environment	Ambient temperature	0 to 40°C		0 to 55°C			
Interface	Dry contact input	EPO / Remote ON / Remote OFF					
	Dry contact output	General alarm / AC output / Low battery voltage / AC input abnormal					
	Network support	Depends on optional LAN interface card					
Expected service life (at 30°C ambient temperature)		10 years (excluding battery ⁽³⁾)		10 years			

(1) Switches to battery operation within 20 ms for 50%–100% voltage sags, meeting SEMI F47 requirements for semiconductor manufacturing equipment.

(2) At 25°C ambient temperature and load power factor of 0.8, using new, fully charged batteries.

(3) The service life of batteries is 5 years at 25°C ambient temperature.

3. Features

The product delivers high overload capability, high efficiency, and low noise operation. A wide product lineup also allows users to select the optimal model for specific applications and installation environments.

Key features are described below.

3.1 High overload capability

The product provides high overload capability, enabling reliable backup of motor-driven equipment with temporary peak power demands, including industrial robots and freight elevators.

The overload capability during grid operation is 800% for two cycles at the rated frequency, 200% for 30 seconds, and 150% for 60 seconds.

Figure 3 shows the overload capability during backup operation for the *SANUPS N11D*, *SANUPS N11D-Li*, and the conventional *SANUPS E11B*. Compared with the conventional *SANUPS E11B*, the product approximately doubles overload capability. During backup operation, the overload capability is 200% for 1 second, 180% for 10 seconds, and 150% for 60 seconds, allowing the UPS to be sized based on steady-state load requirements. The overload capability of the *SANUPS N11D-C* is 200% for 200 ms and 150% for 500 ms.

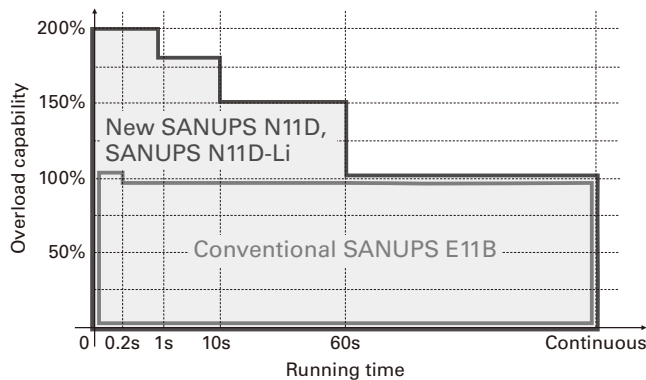


Fig. 3 Overload capability during backup operation

3.2 High efficiency and energy savings

Figure 4 shows the inverter circuit and switching waveforms. In the conventional inverter circuit, all four power devices were switched at high frequency. In the new product, switching losses were reduced by switching one inverter leg at line frequency, reducing the number of high-frequency switching operations. As a result, conversion efficiency reached a maximum of 98.0% for the 2 kVA model, a 1.0% improvement over the conventional product, and 98.6% for the 3 kVA model,

a 0.7% improvement. Higher efficiency reduces power consumption and heat generation, helping reduce CO₂ emissions. As a result, the product has been certified as an Eco Products Plus⁽¹⁾ product under the company's internal environmental standards for products with exceptionally low environmental impact.

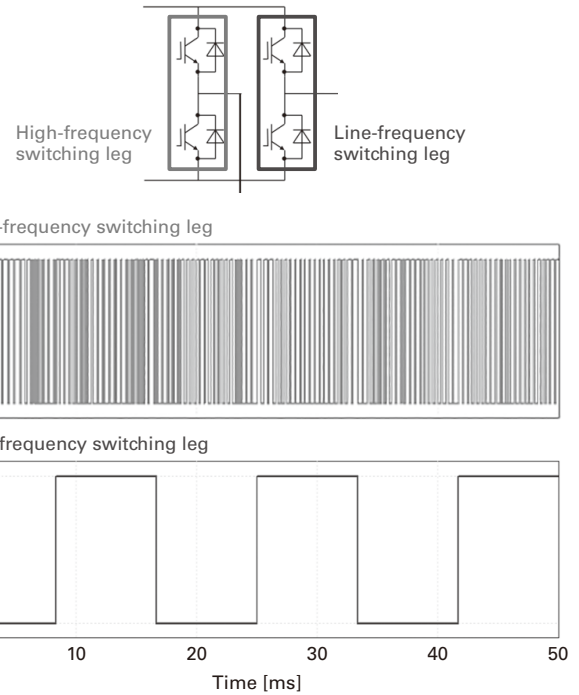


Fig. 4 Inverter circuit and switching waveforms

Figure 5 shows the power supply configuration of the *SANUPS N11D-C* during backup operation. Lead-acid batteries are not suitable for high-current charging, whereas EDLCs are well suited for high-current charging applications. By using the bidirectional inverter to charge the EDLC with regenerative power, energy generated during motor deceleration can be effectively reused. In general, this approach contributes to improved system energy efficiency by reusing energy that would otherwise be dissipated as heat in regenerative resistors.

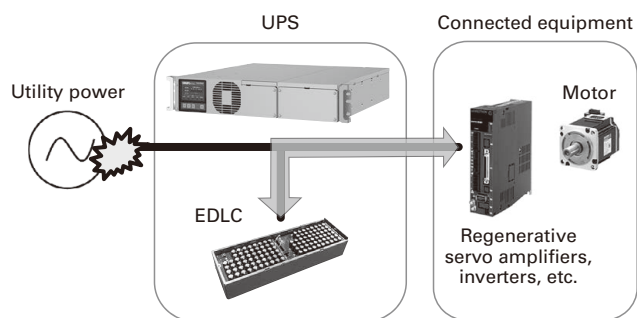


Fig. 5 Power supply configuration of the *SANUPS N11D-C* during backup operation

3.3 Low noise

The product optimizes cooling performance by adjusting the fan speed according to the operating mode, whether grid operation or backup operation. With a noise level of 40 dB or less during grid operation, it can be installed in noise-sensitive environments with confidence.

3.4 Extensive product lineup

Table 2 shows the product lineup. The lead-acid battery model, *SANUPS N11D*, offers the lowest initial cost among the three models. The lithium-ion battery model, *SANUPS N11D-Li*, is lightweight and provides long service life. To prevent degradation, lead-acid batteries stop charging at 40°C. In contrast, lithium-ion batteries support charging and discharging at temperatures up to 55°C, enabling operation over a wider temperature range. The EDLC model, *SANUPS N11D-C*, supports rapid charging and offers excellent resistance to charge/discharge degradation, making it suitable for compensation for momentary voltage sags on utility power lines.

The three-model lineup allows users to select the optimal model for specific applications and operating environments.

Table 2 *SANUPS N11D* Product Lineup

Model	Energy storage device	Features
SANUPS N11D	Lead-acid battery	Lowest initial cost
SANUPS N11D-Li	Lithium-ion battery	Lightweight, long life, wide operating temperature range
SANUPS N11D-C	EDLC	Suitable for voltage sag compensation

Figures 6 and 7 show the *SANUPS N11D* and *SANUPS N11D-Li* UPS, and the *SANUPS N11D-C*, respectively. The units support wall-, floor-, and rack-mount installation, enabling installation in a wide range of environments. In

addition, as shown in Figure 1, the *SANUPS N11D* and *SANUPS N11D-Li* feature a slim-profile design with a separate battery unit. This provides greater installation flexibility, including installation inside control panels and equipment enclosures where space is limited.



Fig. 6 *SANUPS N11D* and *SANUPS N11D-Li*



Fig. 7 *SANUPS N11D-C*

4. Technical Highlights

4.1 Achieving 200% overload capability

Improving overload capability requires a reactor that maintains stable current control even under high-current conditions.

Figure 8 shows the DC bias characteristics of the reactor. In the conventional product, the reactor exhibited a significant decrease in inductance as current increased. As a result, current controllability deteriorated under high-current conditions. In the new product, a reactor with minimal inductance variation under increasing current was developed, improving current-control stability.

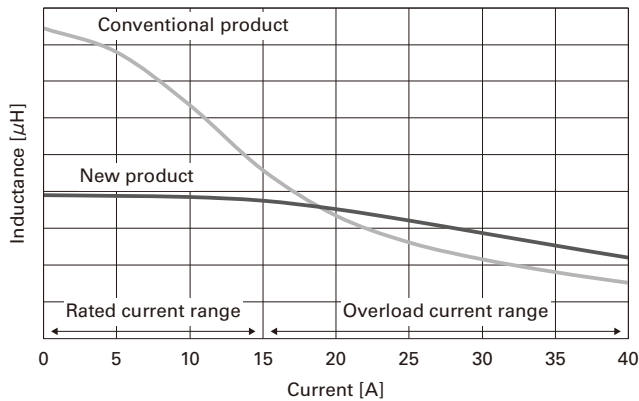
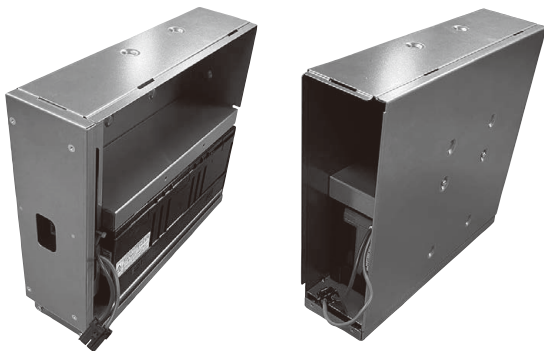


Fig. 8 DC bias characteristics of the reactor

4.2 Structure designed for improved maintainability

Figure 9 shows the battery units of the *SANUPS N11D* and *SANUPS N11D-Li*. To support installation in various environments, including control panels and equipment enclosures, the product was designed to allow battery replacement from either the front or side of the unit, improving maintainability.

Fig. 9 *SANUPS N11D* and *SANUPS N11D-Li* battery units

4.3 Simplified structure

In the conventional product, the power conversion section, control section, and input/output section were configured as separate circuit boards connected by wiring between boards. In the new product, those sections were consolidated onto a single circuit board, reducing both the number of boards and inter-board wiring.

Figure 10 shows the cooling fan mounting structure. In the conventional product, the cooling fan was secured with screws. In the new product, part of the sheet-metal enclosure is used to secure the cooling fan without screws.⁽²⁾

This simplified structure improves manufacturability and helps ensure consistent product quality.

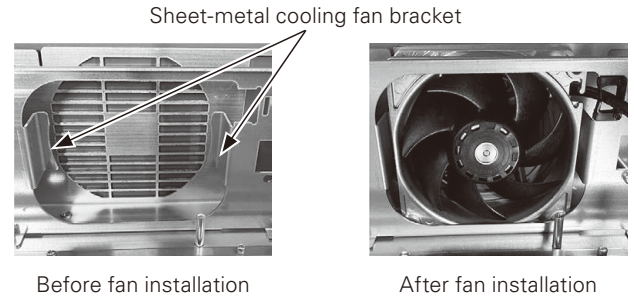


Fig. 10 Fan mounting structure

5. Conclusion

This paper presented the product overview, key features, and technical highlights of the Standby UPS *SANUPS N11D*.

The product offers the following features:

- (1) With overload capability of up to 200% of rated capacity, the UPS can reliably support equipment with temporary peak power demands, including motor-driven equipment.
- (2) Compared with the conventional product, efficiency was improved by up to 1.0% (maximum 98.0% for the 2 kVA model and 98.6% for the 3 kVA model). The high-efficiency design reduces power consumption and CO₂ emissions, contributing to energy savings.
- (3) Noise level is 40 dB or less during grid operation, allowing use in low-noise environments.
- (4) The product lineup includes three types of energy-storage devices and four installation configurations, allowing users to select the optimal product for their specific applications and installation environments.

The standby UPS *SANUPS N11D* provides high installation flexibility by allowing users to select the type of energy-storage device and installation configuration best suited to their application and operating environment. In addition, significantly improved overload capability enables stable power supply to equipment with temporary high power demands.

SANYO DENKI will continue to develop environmentally responsible products that contribute to greater customer value.

- (1) Our products are evaluated throughout their life cycle for factors such as size and weight reduction, reduced power consumption, and lower CO₂ emissions. Products that meet the established criteria are certified as Eco Products, while those that meet more stringent criteria are certified as Eco Products Plus.
- (2) Patent pending.

Author

Yuto Iwasaki

Design Dept., Electronics Company

Works on the development and design of power supply units.

Satoshi Furihata

Design Dept., Electronics Company

Works on the development and design of power supply units.

Yoshitsugu Kashiwagi

Design Dept., Electronics Company

Works on the development and design of power supply units.

Kazuya Nishizawa

Design Dept., Electronics Company

Works on the development and design of power supply units.

Nobuya Otsuki

Design Dept., Electronics Company

Works on the mechanism design of UPS.

Hiroyuki Hanaoka

Design Dept., Electronics Company

Works on the development and design of power supply units.

Kazuya Kudo

Design Dept., Electronics Company

Works on the development and design of power supply units.

Shota Ozawa

Design Dept., Electronics Company

Works on the development and design of power supply units.

Mai Saito

Design Dept., Electronics Company

Works on the development and design of power supply units.

SANMOTION Products

Yasushi Misawa

The SANYO DENKI Group continues to address the needs and challenges of diverse markets and customers while creating new value. In addition to core applications such as semiconductor manufacturing equipment, industrial robots, and machine tools, we are expanding the adoption of SANMOTION products across a wider range of industries—including food, agriculture, forestry, and fisheries—through customized products tailored to specific customer requirements.

This article provides an overview of the SANMOTION products developed in 2025, highlighting their features and how they contribute to our customers and society.

First, we expanded *SANMOTION G* servo system lineup by adding the 48 VDC servo system. Servo performance was significantly improved through higher output and faster response, while achieving a more compact, lightweight, and energy-efficient design. Environmental durability was enhanced through improved operating altitude, vibration resistance, and ambient temperature and humidity performance, while environmental impact was reduced through greater energy efficiency and lower material usage. Compatibility and operability were also improved, enabling reliable use across a wide range of applications.

Next, we developed the *SANMOTION C S300* Motion Controller. A high-speed CPU and optimized software improve control performance to four times that of current models, while expanded I/O supports up to 128 I/O points. Safety has been enhanced with a secure boot and simplified software updates. A built-in drive recorder enables rapid fault identification, reducing equipment downtime. This product contributes to improving the performance of customers' equipment and creating new value.

Below are the overviews of new products and their features.

■ The *SANMOTION G* 48 VDC Servo Systems

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.

The features are as follows.

1. Powerful servo performance

The servo motor achieves a shorter overall length through optimized electromagnetic design and a downsized encoder. Optimized winding specifications increase the maximum speed to 6,500 min⁻¹, enabling higher output and improved torque density compared with current *SANMOTION R* series models. It is equipped with a high-resolution, battery-less absolute encoder with up to 27-bit resolution, ensuring stable repeatability and high-precision positioning. The servo amplifier features improved voltage utilization and output current, enhancing motor torque in the high-speed range. This expands the motor's output range and shortens acceleration and deceleration times. In addition, the frequency

response of the speed control system has been increased to approximately 2.2 times (1.5 kHz) that of current models, reducing positioning settling time to approximately one-eighth.

2. Enhanced environmental durability

Environmental durability was enhanced through structural and thermal simulations, along with verification testing. The servo motor offers twice the vibration resistance, while the servo amplifier supports an operating temperature range approximately 1.5 times wider. In addition, the allowable operating altitude has been doubled, enabling reliable operation in harsher environments.

3. Environmental friendliness

The servo motor achieves up to 19% shorter length and 32% lower mass through optimized electromagnetic design, winding specifications, and encoder downsizing, while improving efficiency by up to 3.2%.

The servo amplifier increases rated and peak output current by 7% and 5%, respectively, while raising switching frequency by 16%. By adopting low-loss power devices, power loss is reduced by up to 12.8% while improving efficiency by up to 1.6%. In addition, structural optimization reduces the servo amplifier mass by up to 9%.

4. Friendliness to customers

The servo motor integrates the motor power cable and holding brake cable into a single cable, reducing the number of required components. It is compatible with current *SANMOTION R* series models, enabling easy replacement.

In addition to EtherCAT*, the servo amplifier supports analog and pulse-train command inputs. The lineup has also been expanded to include models with up to 400 W output, doubling the maximum output from current 200 W models.

This newly developed *SANMOTION G* 48 VDC servo system delivers significantly improved servo performance and reliability, while achieving energy savings and a more compact, lightweight design, ensuring stable operation even in demanding environments.



Fig. 1 48 VDC Servo Systems

* EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

■ The *SANMOTION C S300* Motion Controller

As manufacturing automation advances, demand is increasing for motion controllers capable of high-speed multi-axis control and high scalability in manufacturing equipment and production lines. In fields requiring advanced control performance, such as semiconductor manufacturing equipment, controllers are increasingly expected to deliver higher performance while supporting space savings, safety, and reliability.

To meet these requirements, we have developed the *SANMOTION C S300* Motion Controller, offering high performance, scalability, and enhanced security.

The features are as follows.

1. Compact size and high performance

A low-power, high-speed CPU combined with optimized OS and motion control software delivers control performance four times higher than current models, supporting up to 32 axes at a 1 ms Calculation cycle. In addition, the high-density board design reduces volume by 9%. The improved control performance and compact design contribute to space savings and higher equipment productivity.

2. High scalability

The number of built-in digital outputs has been expanded to 16 points, double that of current models.

Additional I/O expansion modules enable flexible expansion of digital I/O. Up to four modules can be added, supporting up to 128 digital inputs and 128 digital outputs for flexible system configuration tailored to specific customer applications.

Communication between modules uses EtherCAT*, enabling high-speed, reliable data transfer and improved system responsiveness.

3. Safe system configuration

Secure boot ensures that only authorized software is executed, preventing unauthorized access and significantly improving system safety and reliability. Software updates, including new features and performance enhancements, can be downloaded from our website and applied via a standard web browser, without dedicated tools. This enables easy updates and helps maintain the system in a secure, up-to-date state.

4. Reduced equipment downtime

A built-in drive recorder logs and saves system status information based on triggers such as EtherCAT* communication data or images captured by a web camera. For example, data can be logged in response to triggers such as equipment collisions or emergency stop signals.

The *SANMOTION C S300* Motion

Controller combines compact size, high performance, and scalability with enhanced safety and reliability, contributing to increased value in customer equipment.

Details on this product are covered in a separate article in this issue.

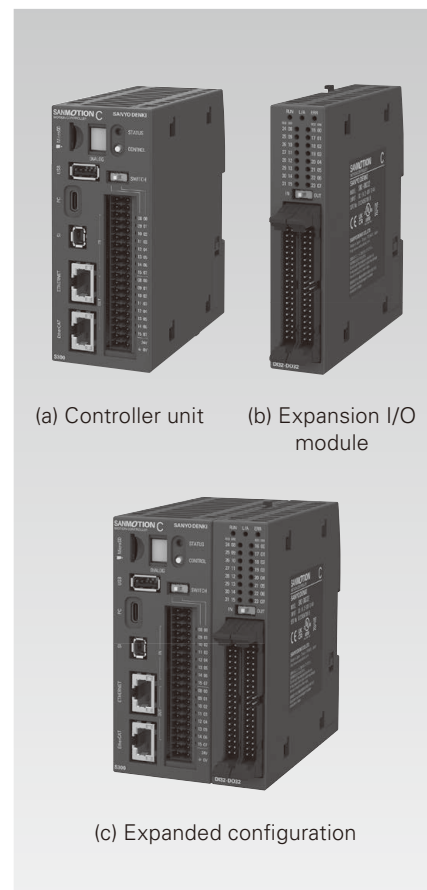


Fig. 2 The *SANMOTION C S300* Motion Controller

* EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Author

Yasushi Misawa

Design Dept., Motion Company

Works on the design and development of servo motors.

Development of the *SANMOTION C S300* Motion Controller

Hiroto Endo Tomonobu Tazaki Tatsuya Okazaki Masayuki Mizutani

Yasuhiro Seki Hyukjun Kwon Tomoya Oyama Shigeki Sato

1. Introduction

In recent years, manufacturers have increasingly required autonomous production lines capable that can flexibly adapt to fluctuations in production demand. To ensure stable production, motion controllers must provide highly accurate control of multiple motors while offering the flexibility to monitor production status and expand the system as needed.

In addition, while advances in IoT technologies have made it easier to monitor production equipment and collect operational data, they have also increased the risk of unauthorized external access.

To address these challenges, we developed a motion controller with improved control performance, greater scalability, and strengthened security features.

This paper presents an overview of the newly added *SANMOTION C* Motion Controller (hereinafter, “controller unit”) and expansion I/O module, and describes their features.

2. Product Overview

The new product consists of a controller unit and an expansion I/O module that mounts to the side of the

controller unit to provide additional digital I/O functions.

2.1 Appearance

Figure 1 shows the products and Figure 2 shows their dimensions. Two controller unit models are available: the Advanced Model (model: SMC300-A), which supports interpolation control, and the Basic Model (model: SMC300-B), optimized for PTP (Point-to-Point) positioning control.

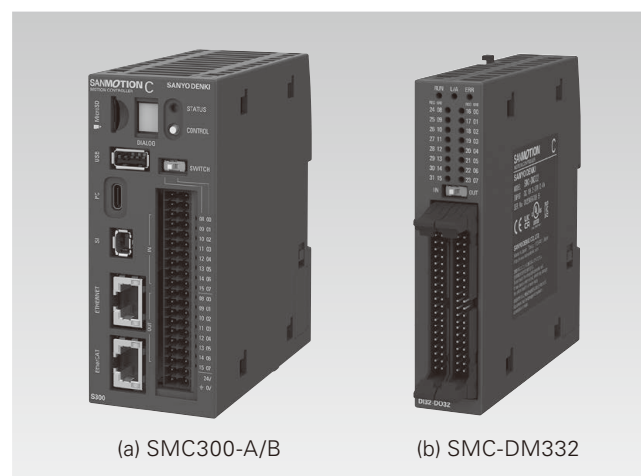


Fig. 1 *SANMOTION C S300* Motion Controller

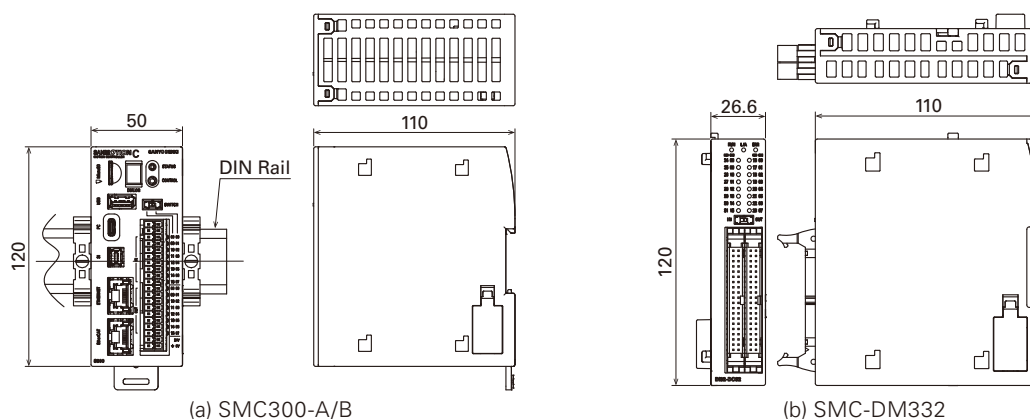


Fig. 2 Dimensions of the new products (Unit: mm)

An expansion I/O module (model: SMC-DM332) with 32 digital inputs and 32 digital outputs is also available.

The products support DIN-rail mounting for easy installation and replacement inside control panels.

2.2 General specifications

Table 1 and 2 list the specifications of the controller unit and expansion I/O module, respectively.

EtherCAT, an open industrial network standard that provides high synchronization accuracy and efficient data transfer, is used as the motion network. To enable flexible

communication with sensors and host computers used in manufacturing environments, the controller is equipped with Ethernet, RS485, and USB interfaces, and supports open protocols such as OPC UA and Modbus TCP. A microSD card slot is provided for recording equipment status changes and fault conditions. The recorded data can be analyzed to evaluate production-line operating efficiency and investigate abnormal conditions.

The product complies with the following standards: UL/cUL (North America), EMC Directive (Europe), UKCA Mark (United Kingdom), and KC Mark (South Korea).

Table 1 Specifications of the controller unit

Model		Advanced model	Basic model
Model no.		SMC300-A	SMC300-B
Interfaces	EtherCAT (100 Mbps) master		
	Ethernet (10/100/1000 Mbps)		
	RS-485 (9600 bps to 115200 bps)		
	USB 3.0 Type A (mass storage devices, wireless adapters, web cameras)		
	USB 2.0 Type C (PC connection)		
	microSD card slot (up to 32 GB)		
Digital input/output		Digital inputs: 16 points, 24 VDC, PNP/NPN common input Digital outputs: 16 points, 24 VDC, 0.5 A/point, sinking output	
Input voltage		19.2 to 30 VDC, 1.2 A (main power supply) 19.2 to 30 VDC, 100 mA min. (I/O power supply)	
Power consumption		29 W	
Cooling method		Forced air cooling	
Dimensions (W × H × D)		50 mm × 120 mm × 110 mm	
Mass		350 g	
Control functions		Sequence control Motion control (Electronic cam, electronic gear, linear interpolation, circular interpolation) Robot control (Cartesian coordinate, SCARA, parallel link)	Sequence control Motion control (PTP control)
Control language		IEC 61131-3 standard programming languages	
		G-code (complies with DIN 66025)	–
Network		Supported industrial protocols (Modbus TCP, OPC UA, EtherNet/IP, MC Protocol, FINS)	
		File sharing server (Samba, FTP(S))	
		Web server (web applications, web visualization)	
Security		Software updates, secure boot, IP filtering, interface enable/disable	
Maintenance		Drive recorder, email notification, remote monitoring	
Certifications	UL/cUL	UL 61010-1, UL 61010-2-201	
		CSA C22.2 No. 61010-2-201, CSA C22.2 NO. 61010-1-12	
	EMC Directive	EN61131-2:2007, ENIEC 63000:2018	
	UKCA Mark	EN61131-2:2007, ENIEC 63000:2018	
		KS C 9610-6-4:2022, KS C 9610-6-2:2019	

Table 2 Specifications of expansion I/O module

Model no.		SMC-DM332
Digital input/output		Digital input: 32 points, 24 VDC, PNP/NPN common input
		Digital output: 32 points, 24 VDC, 0.1 A/point, sinking output
Input voltage		19.2 to 30 VDC, 0.4 A
Fieldbus communication		EtherCAT (100 Mbps) slave
Digital I/O connector		MIL type connector (XG4A-4039-A)
Display		Selectable input/output display, 16 LEDs (three-color LED indicators)
Dimensions (W × H × D)		26.6 mm × 120 mm × 110 mm
Mass		200 g
Certifications	UL/cUL	UL 61010-1, UL 61010-2-201
		CSA C22.2 No. 61010-2-201, CSA C22.2 NO. 61010-1-12
	EMC Directive	EN61131-2:2007, ENIEC 63000:2018
	UKCA Mark	EN61131-2:2007, ENIEC 63000:2018
	KC Mark	KS C 9610-6-4:2022, KS C 9610-6-2:2019

3. Product Features

The controller unit is a high-performance, highly scalable motion controller with advanced networking capabilities.

To maintain compatibility with the *SANMOTION C S200* series, the front-panel interfaces have been retained, while expansion connectors have been added on the side to support system expansion based on production-line requirements.

As connections to external networks increase, so do the risks of unauthorized access and other security threats. To address these risks, the controller unit incorporates enhanced security features, including secure boot, strengthened password protection, and HTTPS support.

In addition, the controller unit includes a drive record that automatically saves operational data and video when equipment trouble occurs, allowing operating conditions at the time of the event to be reproduced.

3.1 High performance and compact design

3.1.1 High performance

The controller unit significantly improves processing capability through enhanced hardware and optimized software. CPU-core allocation was redesigned by separating the real-time motion control and user-program execution into dedicated cores, enabling stable real-time control.

Compared with the current product, control speed was increased fourfold, reducing cycle times for robots and multi-axis systems and supporting digital transformation (DX) in manufacturing environments. Table 3 compares control performance with the current product.

Table 3 Control performance comparison with the current product

Items	New product (<i>SANMOTION C S300</i>)	Current product (<i>SANMOTION C S200</i>)
Calculation cycle Unit: ms	1	4
Number of controllable axes Unit: axis	32	8

The controller unit also incorporates an EtherCAT branch circuit for connecting expansion I/O modules. Multiple PHYs (circuits that convert digital and electrical signals) are mounted on the board to implement the branch configuration.

Stable signal integrity was achieved by eliminating pulse transformers between PHYs, minimizing wiring length, and properly matching differential impedance, enabling high-speed, stable EtherCAT communication.

3.1.2 Compact design

In addition to selecting compact components, the controller was downsized by optimizing signal routing and component placement.

The unit consists of a CPU board and power supply board. To reduce enclosure width, the spacing between the boards was minimized. Although the reduced spacing increased internal heat generation, internal temperature rise was suppressed by optimally positioning the cooling fan.

As a result, while retaining the same front panel interfaces as the current product, the controller width was reduced by 5 mm and enclosure volume by 9%. This compact design

helps reduce control panel space requirements. Table 4 compares dimensions with the current product.

Table 4 Dimensional comparison with the current product

Items	New product (SANMOTION C S300)	Current product (SANMOTION C S200)
Dimensions (W x H x D) Unit: mm	50 × 120 × 110 (-5 mm vs. current product)	55 × 120 × 110
Volume Unit: cm³	660 (91% of current product)	726

3.2 Flexible expansion

As shown in Figure 3, the controller unit allows designers to expand functions as needed by connecting expansion I/O modules to the right side of the controller.

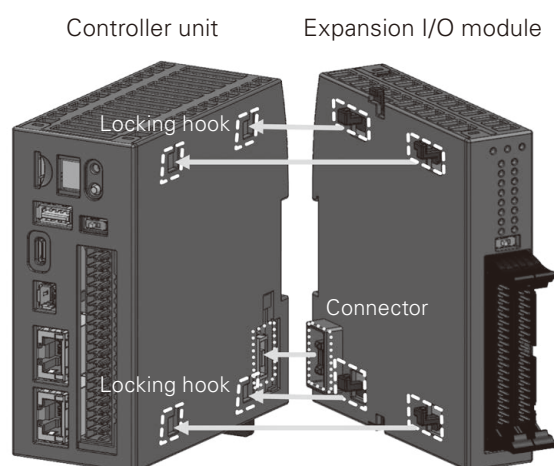


Fig. 3 Side coupling mechanism (expansion modules)

Up to four expansion I/O modules can be connected, supporting up to 128 digital inputs and 128 digital outputs. EtherCAT was adopted for communication between expansion I/O modules, enabling high-speed, reliable data transfer.

In addition, the network scan feature of the integrated development software automatically detects the connected expansion I/O configuration, simplifying module setup for machine systems.

To simplify installation inside control panels, a new locking mechanism was developed, as shown in Figure 4, allowing the side and rear sections to be secured simultaneously with a one-touch operation.⁽¹⁾ Integrating the four side and rear locking points into a single mechanism allows locking by

simply sliding the locking component upward, improving efficiency inside control panels.

(1) Patent application being processed

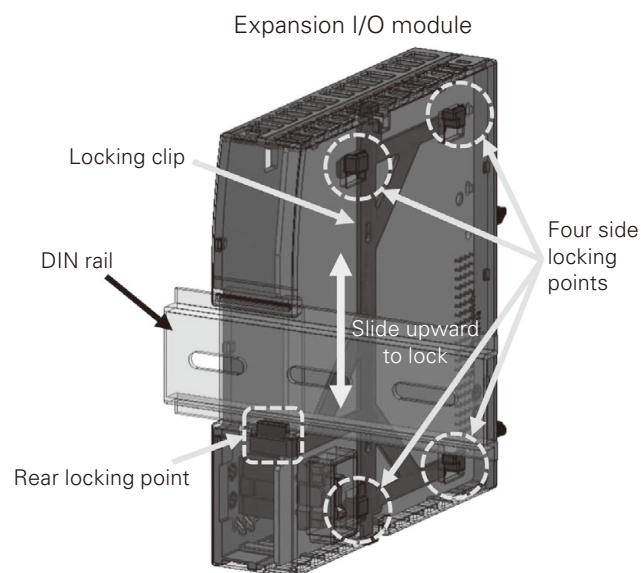


Fig. 4 Rear mounting mechanism (DIN rail)

3.3 Enhanced security

The controller unit incorporates enhanced security measures to prevent unauthorized access from external networks and ensure secure data communication.

3.3.1 Secure boot

To prevent execution of tampered firmware resulting from unauthorized access, the controller unit incorporates secure boot.

As shown in Figure 5, secure boot verifies firmware integrity during startup and prevents the controller unit from booting if tampering is detected. This helps prevent equipment malfunction and accidents caused by unauthorized access.

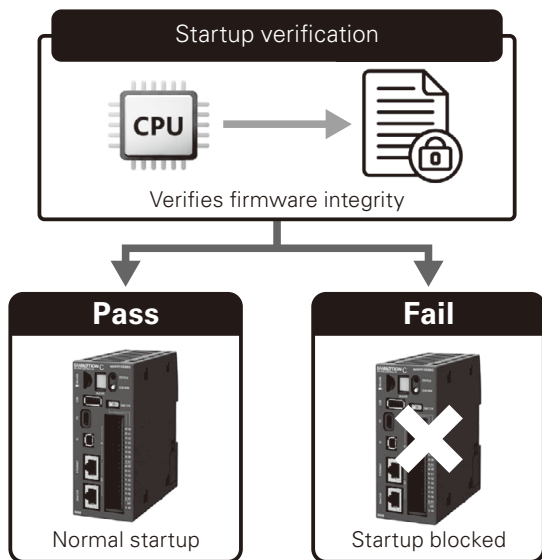


Fig. 5 Secure boot

3.3.2 Software updates

New software vulnerabilities may be discovered after the controller unit is shipped. If left unaddressed, these vulnerabilities could allow unauthorized access or data tampering, potentially affecting customer equipment.

To address this risk, the new product supports software updates after shipment, allowing security patches to be applied, as shown in Figure 6. Customers can download update files from our website and install them easily through a web browser.

This enables customers to maintain the latest security protections and use the controller unit securely over the long term.

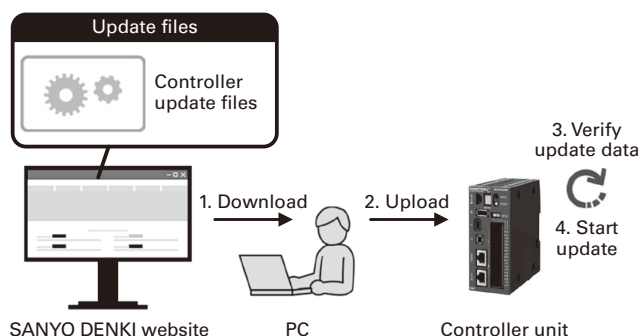


Fig. 6 Software update procedure

3.3.3 Strengthened security features

In addition to secure boot and software updates, the controller unit incorporates the security measures shown in Table 5 to help protect against unauthorized access. These measures help prevent unauthorized changes to machine settings and data leakage.

Table 5 Security features

Feature	Description
Password policy	- Controller unit login passwords must meet minimum length requirements and include uppercase/lowercase letters, numbers, and symbols. - Locks accounts after a specified number of failed login attempts.
HTTPS	Encrypts communication with web applications accessed through a web browser to prevent tampering by unauthorized third parties.
IP filtering	Blocks access from unauthorized IP addresses to prevent unauthorized connections and operations.
Interface control Enable/Disable	Enables or disables USB and microSD interfaces to prevent unauthorized access.
Service control Enable/Disable	Enables or disables file-sharing services to prevent unauthorized access.

3.4 Enhanced maintenance

To speed troubleshooting and system recovery, the controller unit automatically records and stores motor operating data and EtherCAT communication data. This allows events before and after a failure to be traced chronologically, enabling more efficient fault analysis and recovery.

In addition, by connecting a web camera, users can review motor operating data and recorded video simultaneously, as shown in Figure 7, reducing troubleshooting and recovery time.

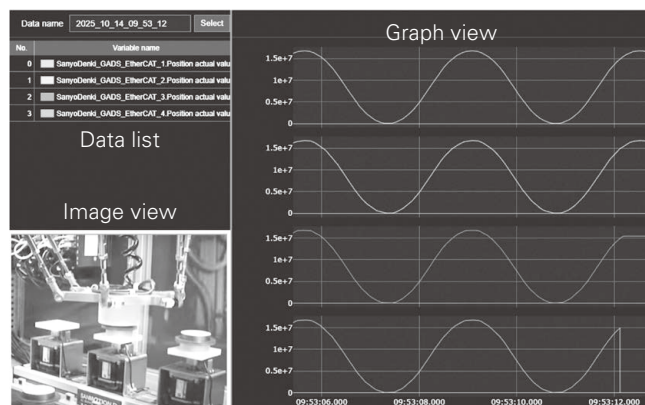


Fig. 7 Recorded data and image screen

4. Conclusion

This paper introduced the *SANMOTION C S300* Motion Controller and its key features. Key features are summarized below.

1. High performance and compact design

The controller unit reduces volume to 91% of the current product. Processing capability was increased fourfold through enhanced hardware and optimized software. These improvements help reduce control panel space requirements and shorten cycle times for robots and multi-axis equipment in manufacturing environments.

2. Flexible expansion

The controller unit supports EtherCAT-based I/O expansion, allowing functions to be added as needed. It also features a redesigned DIN rail mounting structure that improves maintenance efficiency inside control panels.

3. Enhanced security

To prevent program tampering caused by unauthorized external access, the controller unit incorporates a secure boot, allowing only authenticated software to boot.

The controller also supports software updates with the latest security protections, improving safety and reliability.

4. Enhanced maintenance

To speed troubleshooting, the controller unit automatically records and stores motor operating data and communication data. By connecting a web camera, users can review motor operating data and recorded video simultaneously, significantly reducing troubleshooting time.

The new controller improves control performance, scalability, security, and maintainability.

We will continue developing products that help customers create new value.

The company names, product names, and network protocol names mentioned in this article are the trademarks or registered trademarks of their respective companies.

Author

Hiroto Endo

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

Tomonobu Tazaki

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

Tatsuya Okazaki

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

Masayuki Mizutani

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

Yasuhiro Seki

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

Hyukjun Kwon

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

Tomoya Oyama

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

Shigeki Sato

Design Dept., Electronics Company

Works on the design and development of Servo Systems products.

List of Awarded and Nominated Engineers for the 74th JEMA Technological Achievement Award in 2025

Heavy Electrical Category			
Prize	Title	Department	Name
Encouragement Award	Development of the <i>SANUPS W83A</i> that Supports Various Renewable Energy Sources	Design Dept., Electronics Company	Takashi Kobayashi, Takuya Ota, Makoto Ishida, Katsutoshi Tanahashi, Yuji Wada
	Development of an Energy-Efficient Variable-Speed Synchronous Motor	Design Dept., Motion Company	Manabu Horiuchi, Mai Ishikawa, Masaaki Matsuyama, Tomohiro Harada
		Product Application Development Sect., Production Engineering Dept., Motion Company	Takashi Matsushita
	Development of a High-Performance Counter Rotating Fan for High-Density, High-Heat Equipment	Design Dept., San Ace Company	Yusuke Okuda, Naohide Kamada, Shuta Yoshioka, Yukihiro Nagatsuka
		SANYO DENKI TAIWAN CO., LTD	Yen Junchieh
	Development of the <i>SANMOTION G 2-Axis</i> Integrated AC Servo Amplifier	Application Engineering Dept.	Tetsuya Hayashi
		Design Dept., Electronics Company	Keisuke Ishizaki, Masanao Somemiya, Mitsuhiro Nishimura, Satoshi Hiramitsu
	Conformal Coating Removal System Using a Laser Marker	Subsect. 1, Production Engineering Sect., Production Dept., San Ace Company	Masashi Nomura, Masahiro Tatenuki
	Eliminating PCB Defects with Vision Cameras and Detection Sensors	Production Dept. 2, Sect. 2, SANYO DENKI Techno Service CO., LTD.	Takahiro Kaneko
		Subsect. 2, Production Engineering Sect., Production Dept., Electronics Company	Kazuhiro Yoshida
		Production Dept. 2, Sect. 1, SANYO DENKI Techno Service CO., LTD.	Kiyoshi Seki
		Production Dept. 2, Sect. 2, Unit 2, SANYO DENKI Techno Service CO., LTD.	Takahiro Yamaura
	Development of an Automatic Adhesive Dispensing System for Motor Shafts	Subsect. 1, Production Engineering and Development Sect., Production Engineering Dept., Motion Company	Yuki Matsubara

Department names are those at the time of nomination.

Major Patents

■ Patents registered in FY 2025

Patent Number	Title	Inventor(s)
Japan - 07744786	AXIAL FAN	Yusuke Okuda, Hiromitsu Kuribayashi
Japan - 07743337	POWER CONVERSION DEVICE	Satoshi Furihata, Minoru Yanagisawa
Japan - 07737268	INPUT POWER MONITORING CIRCUIT	Takashi Kataoka, Noriaki Kasuga, Masaki Miyashita
Japan - 07733492	MOTOR-SPECIFIC ELECTROMAGNETIC BRAKING DEVICE	Masahiro Yamaguchi
Japan - 07695208	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide, Yoshiyuki Usui
Japan - 07689901	MOTOR CONTROL APPARATUS	Takashi Kataoka
Japan - 07689864	WATERPROOF FAN	Munenori Takakuwa, Hyukjun Kwon
Japan - 07671197	POWER CONVERSION DEVICE	Minoru Yanagisawa, Satoshi Furihata
Japan - 07657683	AXIAL FAN	Yoshihisa Yamazaki
Japan - 07657659	LINEAR HEAD MODULE	Satoshi Inaba, Yuki Onda, Yasushi Misawa
Japan - 07652642	POWER CONVERSION DEVICE AND UNINTERRUPTIBLE POWER SUPPLY	Satoshi Furihata, Minoru Yanagisawa
Japan - 07642472	AXIAL FAN	Yoshihisa Yamazaki
Japan - 07638814	AXIAL FAN	Yoshihisa Yamazaki, Kakuhiko Hata, Shuji Miyazawa
Japan - 07635059	SERVO SYSTEM	Hideaki Kodama
Japan - 07634421	REVERSIBLE FAN	Yoshihisa Yamazaki
Japan - 07633878	REVERSIBLE FAN	Yoshihisa Yamazaki
Japan - 07627635	POWER CONVERSION DEVICE	Minoru Yanagisawa
Japan - 07625389	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide, Yosei Hirano
U.S. - 12480505	AXIAL FAN	Yusuke Okuda, Yen Junchieh
U.S. - 12476573	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Shunichi Miyazaki, Toshio Hiraide
U.S. - 12421970	AXIAL FAN	Atsushi Yanagisawa, Katsumichi Ishihara
U.S. - 12289015	MOTOR ARMATURE STRUCTURE AND MOTOR ARMATURE MANUFACTURING METHOD	Manabu Horiuchi, Shintarou Koichi, Yasushi Misawa
U.S. - 12283855	ROTOR OF INTERIOR PERMANENT MAGNET SYNCHRONOUS MOTOR	Manabu Horiuchi, Kojiro Kawagishi, Yasushi Misawa
U.S. - 12203487	AXIAL FAN	Yoshihisa Yamazaki, Masashi Miyazawa
U.S. - 12512774	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Shunichi Miyazaki, Yoshiyuki Usui
China - ZL202110276160.9	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
China - ZL202080082281.3	ROTARY ELECTRIC MOTOR	Manabu Horiuchi, Mai Shimizu, Takashi Matsushita, Yasushi Misawa, Co-invented with: Japan Aviation Electronics Industry, Ltd.
China - ZL202011531449.2	MOTOR CONTROL APPARATUS AND MOTOR CONTROL METHOD	Yuji Ide, Toshio Hiraide, Michio Kitahara
China - ZL202011299806.7	MOTOR CONTROL DEVICE AND INSULATION RESISTANCE DETECTION METHOD OF SAME	Yuji Ide, Keigo Kikuchi, Michio Kitahara, Toshio Hiraide
China - ZL202011095608.9	MOTOR CONTROL DEVICE AND INSULATION RESISTANCE DETECTION METHOD OF SAME	Yuji Ide, Keigo Kikuchi, Toshio Hiraide
China - ZL202010673386.8	MOTOR CONTROL APPARATUS AND INSULATION RESISTANCE DETECTION METHOD FOR SAME	Yuji Ide, Keigo Kikuchi, Toshio Hiraide, Masakazu Sakai

Patent Number	Title	Inventor(s)
China - ZL202010186114.5	MOLDED STRUCTURE OF BRUSHLESS FAN MOTOR AND METHOD FOR MOLDING BRUSHLESS FAN MOTOR	Munenori Takakuwa, Kakuhiko Hata, Yukihiro Nagatsuka
China - ZL201911335867.1	BOBBIN STRUCTURE OF ARMATURE	Manabu Horiuchi, Hiroki Sagara, Jun Kitajima, Mai Shimizu, Takashi Matsushita
China - ZL201911315659.5	ARMATURE STRUCTURE OF THREE-PHASE MOTOR	Manabu Horiuchi, Hiroki Sagara, Jun Kitajima, Mai Shimizu
Taiwan - I896763	ROTOR STRUCTURE OF SYNCHRONOUS MOTOR	Manabu Horiuchi, Keisuke Nagata
Taiwan - I890774	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
Taiwan - I890716	MOTOR CONTROL APPARATUS AND MOTOR CONTROL METHOD	Yuji Ide, Toshio Hiraide, Michio Kitahara
Taiwan - I889778	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
Hong Kong - HK40029157	BOBBIN STRUCTURE OF ARMATURE	Manabu Horiuchi, Hiroki Sagara, Jun Kitajima, Mai Shimizu, Takashi Matsushita
Hong Kong - HK40026893	ARMATURE STRUCTURE OF THREE-PHASE MOTOR	Manabu Horiuchi, Hiroki Sagara, Jun Kitajima, Mai Shimizu
Korea - 102838221	FRAME STRUCTURE OF MOTOR AND METHOD FOR MANUFACTURING FRAME AND ARMATURE OF MOTOR	Manabu Horiuchi, Yasushi Misawa, Jun Kitajima, Mai Shimizu
Korea - 102836074	ROTARY ELECTRIC MOTOR	Manabu Horiuchi, Mai Shimizu, Takashi Matsushita, Yasushi Misawa, Co-invented with: Japan Aviation Electronics Industry, Ltd.
Korea - 102780466	ARMATURE STRUCTURE OF THREE-PHASE MOTOR	Manabu Horiuchi, Hiroki Sagara, Jun Kitajima, Mai Shimizu
Europe - 03975387	ROTOR STRUCTURE OF SYNCHRONOUS MOTOR	Manabu Horiuchi, Keisuke Nagata
Europe - 03675327	ARMATURE STRUCTURE OF THREE-PHASE MOTOR	Manabu Horiuchi, Hiroki Sagara, Jun Kitajima, Mai Shimizu
Germany - 102013107269	PERMANENT MAGNET TYPE MOTOR AND METHOD FOR MANUFACTURING PERMANENT MAGNET TYPE MOTOR	Toshihito Miyashita, Manabu Horiuchi
Philippines - 1-2022-050337	AXIAL FAN	Yoshihisa Yamazaki, Kakuhiko Hata, Shuji Miyazawa
Philippines - 1-2022-050189	REVERSIBLE FAN	Yoshihisa Yamazaki
Philippines - 1-2016-000315	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
India - 563957	MOTOR CONTROL DEVICE AND INSULATION RESISTANCE DETECTION METHOD OF SAME	Yuji Ide, Keigo Kikuchi, Toshio Hiraide
India - 558731	MOTOR CONTROL APPARATUS AND INSULATION RESISTANCE DETECTION METHOD FOR SAME	Yuji Ide, Keigo Kikuchi, Toshio Hiraide, Masakazu Sakai

Internal Recognition: Invention Excellence Award

Awarded in May 2025

Prize	Title	Department	Name
Excellence Award	Molded Structure and Manufacturing Method for a Brushless Fan Motor	SANYO DENKI GERMANY GmbH	Munenori Takakuwa
		Design Dept., San Ace Company	Yukihiro Nagatsuka
		Environmental Technology Implementation Dept.	Kakuhiko Hata
	Motor Controller and Insulation Resistance Detection Method	Design Dept., Electronics Company	Yuji Ide, Toshio Hiraide
		Environmental Technology Implementation Dept.	Keigo Kikuchi
	Motor Controller with Protection for Insulation Resistance Detection Circuits	Design Dept., Electronics Company	Yuji Ide, Michio Kitahara, Toshio Hiraide
		Environmental Technology Implementation Dept.	Keigo Kikuchi
	Armature Winding Structure and Winding Method for Motors	Design Dept., Motion Company	Mai Ishikawa
		Product Application Development Sect., Production Engineering Dept., Motion Company	Takashi Matsushita
	Protective Cover for Fan Motors	Design Dept., San Ace Company	Haruhisa Maruyama, Yusuke Okuda, Yoshihisa Yamazaki
	Rotary Electric Motor Stator and Its Assembly	Design Dept., Motion Company	Koji Nakatake, Shogo Yoda, Mitsuaki Shioiri
		Sect. 2, Quality Control Dept., San Ace Company	Yasushi Yoda
		Application Engineering Dept.	Hong Zhang
	Automatic Encoder Verification System	Design Dept., Electronics Company	Masao Mizuguchi, Ryuichi Yanagisawa
	DC Bias Suppression Control for Grid-Tied Inverters	Design Dept., Electronics Company	Makoto Ishida, Minoru Yanagisawa

Internal Recognition: Manufacturing Excellence Award

Awarded in May 2025

Prize	Title	Department	Name
Manufacturing Excellence Award	Insulator Mold Design for Burr Reduction	Subsect. 2, Production Engineering Sect., Production Dept., San Ace Company	Shinsuke Okubo, Taiki Kato
		Design Dept., Electronics Company	Nobuya Otsuki
	Reducing New Product Development Lead Time and Prototype Costs	Subsect. 1, Production Engineering Sect., Production Dept., Electronics Company	Yuki Sato

Technical Papers Published Outside the Company

in General Technical Journals

January to December 2025

Title of Paper	Authors	Name of Journal	Issued on	Publisher
Feature: Product and Technology Development of Member Companies and the Results (2023-2024)	SANYO DENKI CO., LTD	<i>Denki</i> (Electrical Appliances)	2025.4	The Japan Electrical Manufacturers' Association (JEMA)
Manufacturing Professionals	Makoto Ishida, Takuya Ota, Yuji Wada	<i>Monthly Denki to Koji</i> (Electrical Construction and Engineering)	2025.4	Ohmsha, Ltd.
Development of the <i>SANUPS W83A</i> Renewable Energy Inverter	Takuya Ota and others	<i>Monthly JETI</i>	2025.5	Nippon Syuppan Seisaku Center Inc.

Technical Papers Published Outside the Company

January to December 2025

Title of Paper	Authors	Name of Journal	Issued on	Publisher
Evaluation method for instantaneous maximum output of motors suitable for service robots Symposium, 2025 IEEJ Industry Applications Society Conference (JIASC2025)3-S4-5	Satoshi Sugita (Joint author: Investigating R&D Committee on Technology for Utilizing Motor Requirement Items Suitable for Service Robots)	IEEJ Industrial Applications Category Conference	2025.8	IEEJ (The Institute of Electrical Engineers of Japan) IEEJ (D), Industrial Applications Category
Technology for Utilizing Motor Requirement Items Suitable for Service Robots IEEJ Technical Report No. 1605	Satoshi Sugita (Joint author: Investigating R&D Committee on Technology for Utilizing Motor Requirement Items Suitable for Service Robots)	IEEJ Technical Report	2025.11	IEEJ (The Institute of Electrical Engineers of Japan) IEEJ (D), Industrial Applications Category

Note: Some names listed above are unofficial English translations provided for reference only.

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