SANYO DENKI

Technical Report

Feature | Technical Developments in 2021

1979
Head Office

53
May 2022

COLUMN

Cover image:

Head Office

1979

After the closure of our Tokyo Works in March 1973 and the following first oil crisis, we constructed a then-cutting-edge reinforced concrete building in October 1979 as our new head office.

We named the new head office building "Sanyo Building," in which our Executive Office, General Affairs Department, and Sales Department were installed.

Besides, the building was managed and commercially leased by Sanyo Kaihatsu Co., Ltd., one of our subsidiaries, housing external tenants.

The Sanyo Building served as our Head Office until 2013 when it was relocated to the JR Otsuka Minamiguchi Building.

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May 2022

C O N T E N T S

Achieving a Sustainable Society

Toshihiko Baba Executive Operating Officer

Nothing makes us happier than when we receive words of appreciation from our customers, such as comments like “I’m so happy to use SANYO DENKI products”!

This type of feedback motivates us as we pursue our corporate activities throughout the world.

All of our three product brands, *San Ace*, *SANUPS*, and *SANMOTION*, are designed for built-in use in customer equipment.

These products need to interface electrically and mechanically with the equipment they are built into.

For example, with our *San Ace* Cooling Systems products, cooling fans are installed near the heat source of the equipment in which they are installed. Also, these cooling fans are powered by the equipment’s power supply.

With our *SANUPS* Power Systems products, the output of uninterruptible power supplies (UPS) provides the input power to the connected customer equipment. This makes the electrical interface with the connected equipment a very important component of these products.

With our *SANMOTION* Servo Systems products, servo motors provide a driving force in the movable parts of the equipment in which they are installed. Similarly, with servo amplifiers, electrical interface, to which motion controllers are connected, plays an important role.

As these examples show, it is required for those products that are integrated into other equipment to clarify their interfaces in addition to their internal specifications.

To that end, it is necessary to understand the input/output specifications of the connected customer equipment. That is, we need to “know our customers better.”

In other words, we have to work closely with our customers when designing products.

The point is that we need to take a bird's eye view of everything that involves our products.

In October 2020, the Japanese government declared its goal of achieving "carbon neutrality" with virtually zero greenhouse gas emissions by 2050.

This defines greenhouse gas emissions, including CO_2, as those from supply chains. Supply chain emissions are classified as Scope 1 to Scope 3, and it is required to quantify the amount of emissions at each stage of a product's life cycle, ranging from the transportation of raw materials and production to use and disposal of the product. The "carbon neutrality" initiative aims to reduce greenhouse gas emissions from business (Scope 1 and 2) to zero using carbon offsets and other techniques. Moving forward, we will be required to quantify and reduce greenhouse gas emissions that are not under our control (Scope 3: indirect emissions other than Scope 1 and 2).

The point here is also that we need to look at the big picture of everything that involves our corporate activities.

We will push forward with various initiatives to work with our customers throughout the world to help them overcome challenges and make their products top in class. In addition, we will continue to promote corporate activities that take into account the global environment and help realize a sustainable society.

We believe that by vigorously promoting these activities, we will be able to achieve "break the shell," the primary goal of our 9th Medium-term Management Plan.

Cooling Systems Division

Hiromitsu Kuribayashi

In recent years, outdoor digital signage for displaying restaurant advertisements and bus service information has been increasing in size and brightness to achieve clear, bright images that are easy to see even during the daytime. For quick EV chargers installed at shopping center parking lots, thermal management of heat-generating parts has become essential to safely and quickly charge increasingly higher EV battery capacities. To cool such equipment, fans with high splashproof performance and high airflow have been increasingly required.

Furthermore, equipment used in close proximity to people, such as hospital medical equipment and laboratory measurement and analysis equipment, requires quite fans that run quietly without disturbing people around.

Residential ventilation systems are also increasingly storing the thermal energy of discharged air in a heat storage element and then returning it outdoors when outside air is taken in. In this regard, fans with high static pressure that can blow air in both directions are required.

To meet such market demands, we have developed and launched fans with industry-leading performance and reliability.

Below is an overview of the products we developed in 2021.

■ Centrifugal Fan / Splash Proof Centrifugal Fan

AC Fan

• ø250 × 99 mm *San Ace 250AD* 9ADTV type / 9ADW1TV type

Centrifugal fans that can be powered by AC power and offer high airflow are required in equipment such as heat exchangers, fan filter units, air purifiers, inverters, telecom equipment cabinets, industrial equipment (control panels, etc.), food processing machines, and commercial dust collectors.

To meet this market demand, we developed and launched ø250 × 99 mm AC-powered Centrifugal Fans with industry-leading(1) airflow in two types: a 9ADTV type and IP56-rated(2) 9ADW1TV type.

(1) Based on our own research as of April 13, 2021, among equally-sized industrial splashproof centrifugal fans on the market.
(2) IP56 protection rating: The IP Code, or Ingress Protection Code, is defined by International Electrotechnical Commission (IEC) in the IEC 60529 standard "Degrees of Protection Provided by Enclosures (IP Code)" (IEC 60529:2001).

■ Splash Proof Centrifugal Fan

DC Fan

- ø100 × 25 mm *San Ace 100W* 9W2TM type
- ø133 × 91 mm *San Ace 133W* 9W2TJ type

In digital signage, quick EV chargers, and telecom equipment cabinets, which are often installed outdoors, centrifugal fans with higher splashproof performance are required.

To meet this market demand, we developed and launched the ø100 × 25 mm *San Ace 100W* 9W2TM type and ø133 × 91 mm *San Ace 133W* 9W2TJ type Centrifugal Fans with industry-leading(3) airflow and static pressure, as well as an ingress protection rating of IP68(4).

(3) Based on our own research at the time of product release, conducted among equally-sized oil-proof fans on the market.
(4) IP68 protection rating: The IP Code, or Ingress Protection Code, is defined by International Electrotechnical Commission (IEC) in the IEC 60529 standard "Degrees of Protection Provided by Enclosures (IP Code)" (IEC 60529:2001).

■ ACDC Fan and Splash Proof ACDC Fan

AC Fan

- ø172 × 150 × 51 mm *San Ace 172AD* 9AD type / 9ADW type

Air conditioners, inverters, and control panels require AC-powered axial fans with low power consumption and high cooling performance. In addition, operability in harsh environments is also required.

In response to these market demands, we developed and launched ø172 × 150 × 51 mm axial fans with the highest airflow and static pressure in the industry(5) in two types: a *San Ace 172AD* 9AD type and an IP56-rated *San Ace 172AD* 9ADW type.

(5) Based on our own research as of July 14, 2021, among equally-sized industrial splashproof AC fans on the market.

■ Low Noise Fan

DC Fan

- 60 × 60 × 25 mm *San Ace 60* 9RA type
- 80 × 80 × 25 mm *San Ace 80* 9RA type
- 92 × 92 × 25 mm *San Ace 92* 9RA type
- 120 × 120 × 25 mm *San Ace 120* 9RA type

Medical equipment, measuring instruments, arcade machines, and professional AV equipment are often used in close proximity to people and require particularly quiet fans.

To meet this market demand, we developed and launched the *San Ace* 9RA type axial fans that provide the lowest noise levels in the industry(6).

To meet a variety of customer requirements, its lineup offers a total of 58 models with voltage and speed variations: thirteen 60 × 60 mm models, thirteen 80 × 80 mm models, sixteen 92 × 92 mm models, and sixteen 120 × 120 mm models.

(6) Based on our own research as of July 20, 2021, conducted among equally-sized axial DC fans on the market.

■ Reversible Flow Fan

DC Fan

- ø136 × 28 mm *San Ace 136RF* 9RFA type

In recent years, an increasing number of residential ventilation systems achieve energy savings by using a fan that can both blow air out and suck air in with a single fan using a heat storage element. Furthermore, higher airflow is also required for use with today's high-density heat storage elements.

In response, we developed and launched a ø136 × 28 mm *San Ace 136RF* 9RFA type Reversible Flow Fan that provides industry-leading(7) airflow and static pressure.

Details on this new product are covered in a separate article in this Technical Report.

(7) Based on our own research as of August 31, 2021, among equally-sized industrial centrifugal fans on the market.

■ High Static Pressure Fan

DC Fan

• 60 × 60 × 38 mm *San Ace 60* 9HVA type

Today's servers and storage devices are becoming more and more compact and high-tech, generating more heat. As a result, they require fans with higher airflow and static pressure than ever before.

To meet this market demand, we developed and launched a ø60 × 38 mm *San Ace 60* 9HVA type High Airflow Fan that provides industry-leading(8) airflow, static pressure, and energy savings. Details on this new product are covered in a separate article in this Technical Report.

(8) Based on our own research as of November 29, 2021, conducted among equally-sized axial DC fans on the market.

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ø136 × 28 mm *San Ace 136RF* 9RFA Type Reversible Flow Fan

Seiji Takeuchi Osamu Nishikawa Yoshihisa Yamazaki

Tomohide Nonomura Toranosuke Hirata Hiromitsu Kuribayashi

1. Introduction

In recent years, residential ventilation systems have required fans that can blow air in two opposite directions without much difference in noise and with high static pressure. Generally, the human ear perceives large noise level differences as uncomfortable, therefore it is desirable to make fan noise differences between the forward and reverse directions as small as possible. In addition, such systems also require high static pressure of a fan to keep ventilation airflow as constant as possible even when the air pressure changes between inside and outside.

To meet these market demands, we revised our current ø136 × 28 mm 9RF type Reversible Flow Fan and developed a new high-performance 9RFA type Reversible Flow Fan with the same size that features a newly designed impeller, frame, and circuit.

This article will introduce the performance and features of this new product as well as key points of development.

2. Product Features

Figure 1 shows the appearance of the new product.

Its size is ø136 × 28 mm and has a ribbed frame. Compared to the current product, the new product achieves higher static pressure while maintaining the size.

The features of the new product are as follows:

(1) Wind directions controllable

(2) High static pressure

(3) Small noise level difference when run in forward and reverse directions

3. Product Overview

3.1 Dimensions

Figure 2 shows the dimensions of the new product. The new product was designed to be compatible in size and mounting with the current product.

Fig. 1 ø136 × 28 mm *San Ace 136RF* 9RFA type

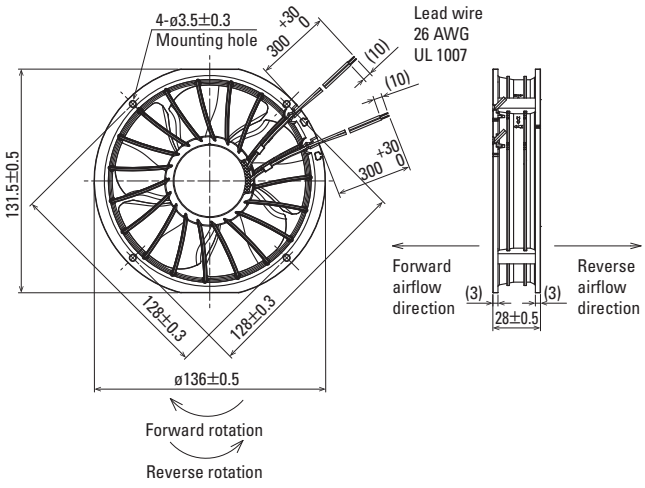

Fig. 2 Dimensions of the *San Ace 136RF* 9RFA type (Unit: mm)

3.2 Specifications

3.2.1 General specifications

Table 1 shows the general specifications of the new product.

The new product is available in models with variations in 12 and 24 VDC rated voltages and two rated speeds of 5,450 min^{-1} (G speed) and 4,350 min^{-1} (H speed).

3.2.2 Airflow vs. static pressure characteristics

Figure 3 shows the airflow vs. static pressure characteristics of new G-speed models, while Figure 4 shows the airflow vs. static pressure characteristics of new H-speed models.

In both figures, measurements of 12 and 24 V models at 0 and 100% PWM duty cycles are plotted.

3.2.3 Wind direction control

Figure 5 shows the PWM characteristics of new G-speed models, while Figure 6 shows the PWM characteristics of new H-speed models.

All new models feature PWM control function for controlling the wind direction and fan speed. At a PWM duty cycle input of 100%, the fan rotates at full speed in the forward direction, blowing air from the label side. On the other hand, at a PWM duty cycle input of 0%, the fan rotates at full speed in the reverse direction, blowing air from the impeller side.

3.2.4 Expected life

The new product has an expected life of 40,000 hours at 60°C (survival rate of 90%, run continuously at rated voltage in free air and at normal humidity).

Table 1 General specifications of new product

Model no.	Airflow direction	Rated voltage [V]	Operating voltage range [V]	PWM duty cycle* [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. airflow [m^3/min]	Max. airflow [CFM]	Max. static pressure [Pa]	Max. static pressure [inchH$_2$O]	Sound pressure level [dB(A)]	Operating temperature range [°C]	Expected service life [h]
9RFA1312P3G001	Forward	12	10.2 to 13.8	100	0.25	3.00	5,450	2.10	74.2	285	1.14	49	-25 to +70	40,000 at 60°C (70,000 at 40°C)
	Reverse			0				2.05	72.4	280	1.12	52		
9RFA1312P3H001	Forward			100	0.16	1.92	4,350	1.67	59.2	185	0.74	44		
	Reverse			0				1.63	57.8	180	0.72	47		
9RFA1324P3G001	Forward	24	20.4 to 27.6	100	0.13	3.12	5,450	2.10	74.2	285	1.14	49		
	Reverse			0				2.05	72.4	280	1.12	52		
9RFA1324P3H001	Forward			100	0.08	1.92	4,350	1.67	59.2	185	0.74	44		
	Reverse			0				1.63	57.8	180	0.72	47		

* Input PWM frequency: 25 kHz
Note: The expected life at an ambient temperature of 40˚C is for reference purposes only.

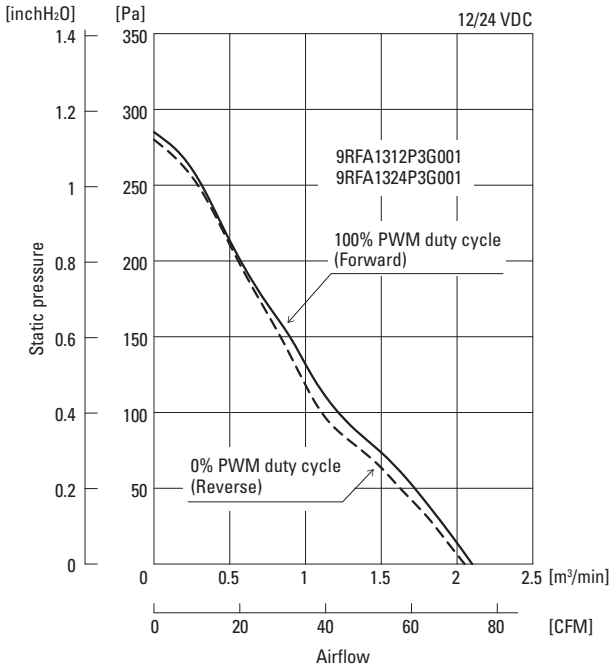

Fig. 3 Airflow vs. static pressure characteristics of new G-speed models

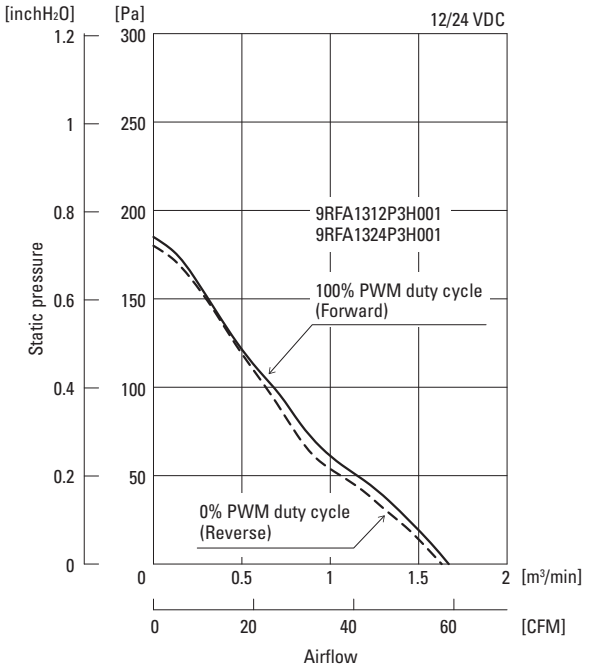

Fig. 4 Airflow vs. static pressure characteristics of new H-speed models

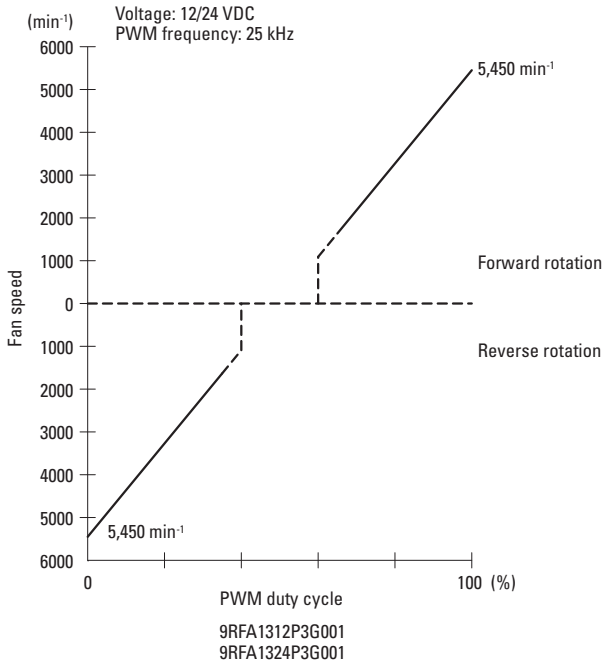

Fig. 5 PWM characteristics of new G-speed models

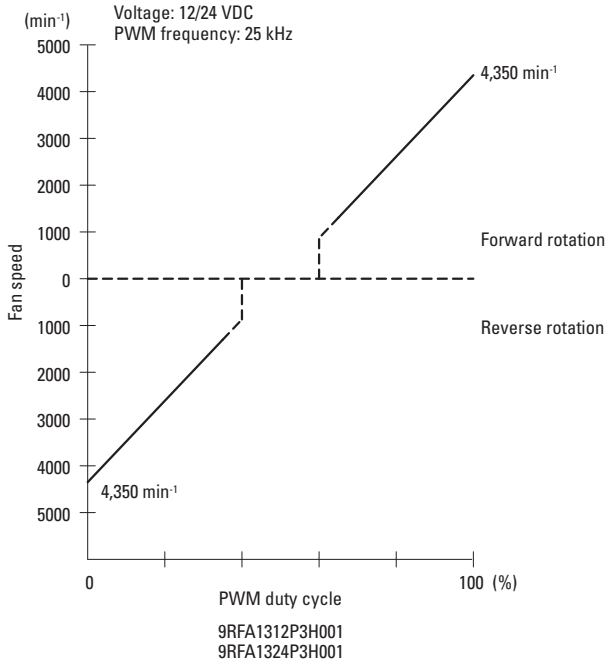

Fig. 6 PWM characteristics of new H-speed models

4. Key Points of Development

To achieve higher static pressure and smaller noise difference between the forward and reverse directions, the impeller and frame forms have been specially designed and the drive circuit has been optimized.

The following sections explain the key points in designing these parts.

4.1 Impeller and frame design

Figure 7 compares the forms of the impellers and frames of the current and new products.

The new product's impeller and frame were designed with the aim to minimize the noise difference between wind directions while increasing the airflow efficiency through repeated simulations and evaluations on actual equipment.

Fig. 7 Form comparison between the new and current products

Figure 8 shows the uniquely designed wire guide on the frame of the new product. The noise level of a fan increases when there are obstacles nearby the fan's inlet side as they disturb the suction wind flow. Unlike regular fans, the new product can rotate the impeller in reverse, blowing air from the impeller side. However, when rotating in reverse, the spokes are located in the upstream of the wind flow and act as obstacle, causing the fan to generate higher noise levels than in the forward direction. In particular, the wind flow

Fig. 8 Wire guide groove form

was disturbed by the thick wire guide groove for passing four lead wires, causing the noise level to increase. To solve this problem, we split the wire guide groove into two thinner ones, successfully reducing the noise level.

4.2 Circuit design

The new product uses a 3-phase motor to smoothly switch the fan's rotational direction, leading to reduced switching noise. In order to achieve high static pressure, the rotational speed is controlled by closed-loop control. Closed-loop control allows higher rotational speed under load than open-loop control. Closed-loop control, however, increases power consumption and raises the temperature in PCB and electronic components. We solved these problems by optimizing the circuit and electronic components.

5. Comparison of New and Current Products

5.1 Comparison of airflow vs. static pressure characteristics

Figure 9 compares the airflow vs. static pressure characteristics of the new and current products. Maximum static pressure has increased to 2.8 times that of the current product.

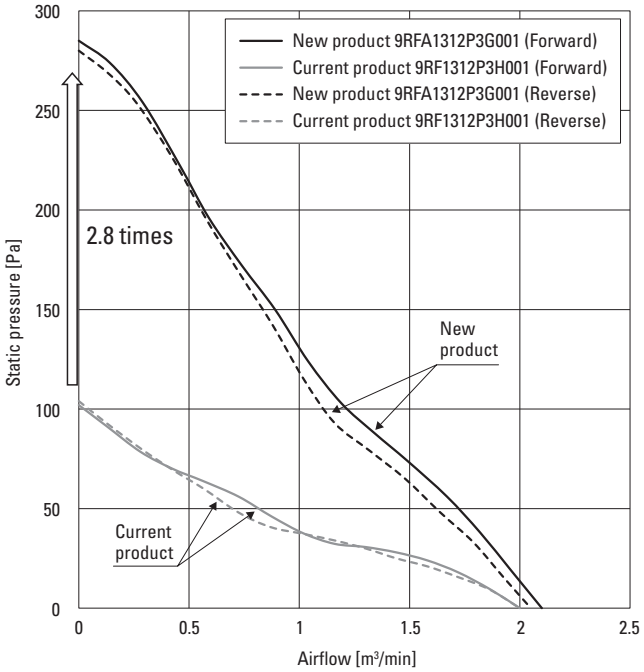

Fig. 9 Comparison of the airflow vs. static pressure characteristics between the new and current products

5.2 Power consumption comparison with the current product at equivalent performance

Figure 10 compares power consumption of new and current products, using an H-speed model specifically, at the point where their cooling performance is equal. This comparison, which compares the new and current products at the estimated operating point as in the figure, shows a 16% reduction in power consumption.

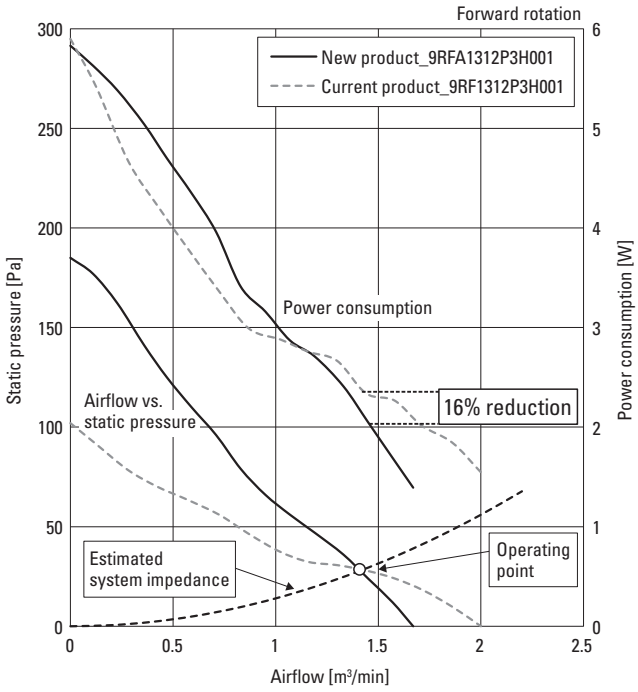

Fig. 10 Power consumption comparison with the current product

6. Conclusion

In this article, we introduced some of the features and performance of the new 9RFA type high-performance Reversible Flow Fan.

The new product has higher static pressure and a smaller noise difference between the forward and reverse directions than the current product. Therefore, the new product can be expected to significantly improve the performance of residential ventilation systems.

We will continue leveraging future-oriented technology in the development of new cooling fans so that we can quickly adapt to customer needs.

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60 × 60 × 38 mm *San Ace 60* 9HVA Type High Static Pressure Fan

Yoshihisa Yamazaki Kakuhiko Hata Shuji Miyazawa

Hikaru Urushimoto Naohide Kamada

1. Introduction

As the IT market continues to grow rapidly in recent years, data processing equipment such as servers, storage devices, and routers has become increasingly sophisticated with high density and high-heat generation, requiring cooling fans with even higher cooling performance. Furthermore, there is an increasing demand to reduce power consumption as the world moves toward a decarbonized society.

Fans with high static pressure performance are required for such equipment. We developed and offered the *San Ace 60* 9HV type High Static Pressure Fan in 2015, but it has become obsolete and is unable to meet the latest performance requirements.

Against such a backdrop, we newly developed and launched the *San Ace 60* 9HVA type (hereinafter, "new product") with high performance and low power consumption.

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

2. Product Features

The new product provides higher static pressure, higher airflow, lower power consumption, and lower noise compared to the 60 × 60 × 38 mm *San Ace 60* 9HV type fan (hereinafter, "current product").

Figure 1 shows the appearance of the new product.

The features of the new product are as follows:

(1) High static pressure and high airflow
(2) High energy efficiency and low noise

The new product's maximum static pressure and airflow are 2,000 Pa and 2.39 m^3/min, respectively, achieving higher static pressure and airflow compared to the current product.

The new product consumes 33.6 W at maximum airflow, which is approximately 1.27 times higher compared to the current product, while maintaining the same power consumption and noise level.

Fig. 1 60 × 60 × 38 mm *San Ace 60* 9HVA type

The details are provided below in "4. Comparison of the New and Current Products".

3. Product Overview

3.1 Dimensions

Figure 2 shows the dimensions of the new product.

The external dimensions, mounting hole pitch, and mounting hole size are the same as those of the current product.

3.2 Specifications

3.2.1 General specifications

Table 1 shows the general specifications of the new product. It has a rated voltage of 12 VDC and a rated speed of 24,800 min^{-1}.

3.2.2 Airflow vs. static pressure characteristics

Figure 3 shows the airflow vs. static pressure characteristics of the new product. It shows the characteristics at 100% and 20% PWM duty cycles and a 12 V rated voltage.

3.2.3 PWM control function

The new product has a PWM control function that enables external control of the fan speed.

3.2.4 Expected life

The new product has an expected life of 40,000 hours at 60°C (survival rate of 90%, run continuously at rated voltage and normal humidity in free air), which is the same as the current product.

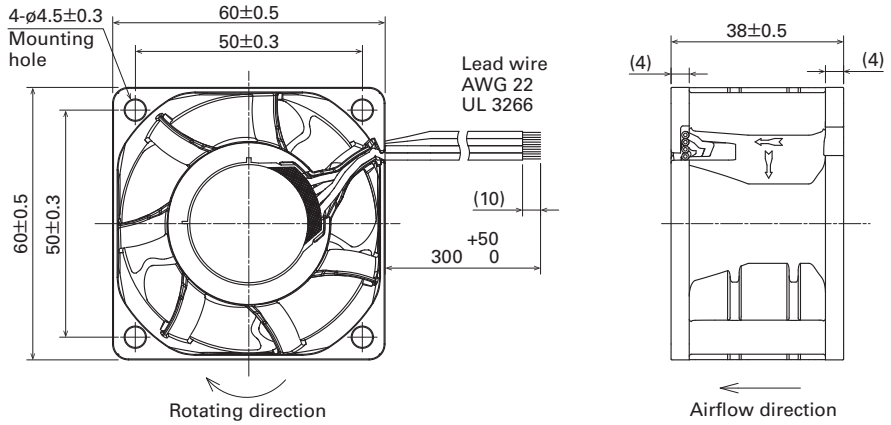

Fig. 2 Dimensions of the new product (unit: mm)

Table 1 General specifications of the new product

Model no.	Rated voltage [V]	Operating voltage range [V]	PWM duty cycle* [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. airflow [m^3/min]	Max. airflow [CFM]	Max. static pressure [Pa]	Max. static pressure [inchH$_2$O]	Sound pressure level [dB(A)]	Operating temperature range [°C]	Expected service life [h]
9HVA0612P1J001	12	10.8 to 13.2	100	2.8	33.6	24,800	2.39	84.3	2,000	8.0	68	-20 to +70	40,000 at 60°C (70,000 at 40°C)
			20	0.11	1.32	5,200	0.48	16.9	91	0.36	34		

* Input PWM frequency: 25 kHz. Speed is 0 min^{-1} at 0% PWM duty cycle.
Note: The expected life at an ambient temperature of 40°C is for reference purposes only.

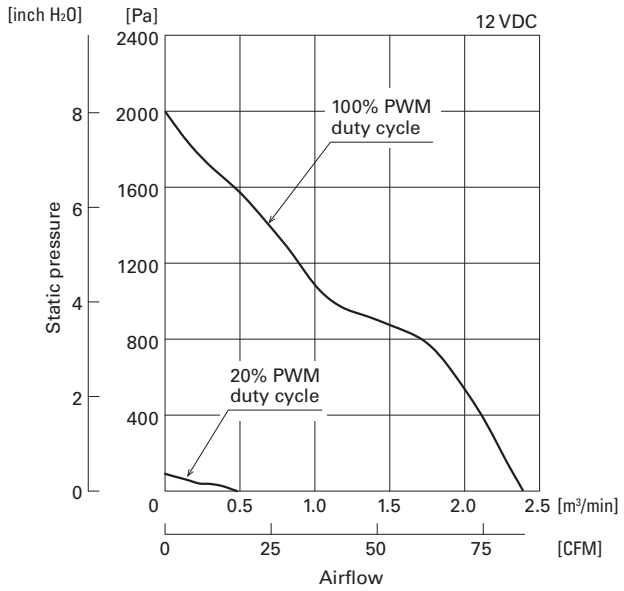

Fig. 3 Airflow vs. static pressure characteristics of the new product

4. Key Points of Development

The new product achieves higher performance compared to the current product. However, we faced the following challenges in the development process.

(1) Increase in fan speed would raise power consumption
(2) Increased power consumption over the entire range of the airflow vs. static pressure characteristics would require a greater number of electronic components and enlarged PCB
(3) Enlarged PCB would limit ventilation area, reducing the airflow vs. static pressure characteristics

To solve such issues for the new product, we redesigned the impeller and frame shapes and newly developed the motor and drive circuit.

The key points of development of these components are explained as follows.

4.1 Motor and drive circuit

The new product is our first 60 × 60 mm fan to use a 3-phase drive motor. Its reduced current ripple reduced the load on the drive circuit and the number of electronic components, securing the space to use the same PCB size as the current product.

This enabled the same motor space as the current product to be secured while increasing the fan speed and securing a greater degree of freedom in designing the impeller and frame.

4.2 Impeller and frame

To improve the fan performance, we made use of our fluid simulation and optimization calculations.

Figure 4 shows the frame outlet sides of the new and current products, while Figure 5 compares the new and current impeller shapes.

Due to the fan structure, the base outer surface and the casing inner surface act as a wall, blocking the air flow.

Therefore, we optimized the rotor and stator blade shapes with an emphasis on the mid-radial portion of the blades, which is less affected by the wall surface.

As shown in Figure 5, the new product's rotor blades have a distinct curved shape. We optimized the rotor blade shape by setting additional geometric parameters on the blade's mid-radial portion to achieve the best performance possible.

As shown in Figure 4, the new product's frame is connected to the casing and base via stator blades like the current product. The new stator blades are curved against the rotor blades' rotational direction. The shape of the stator

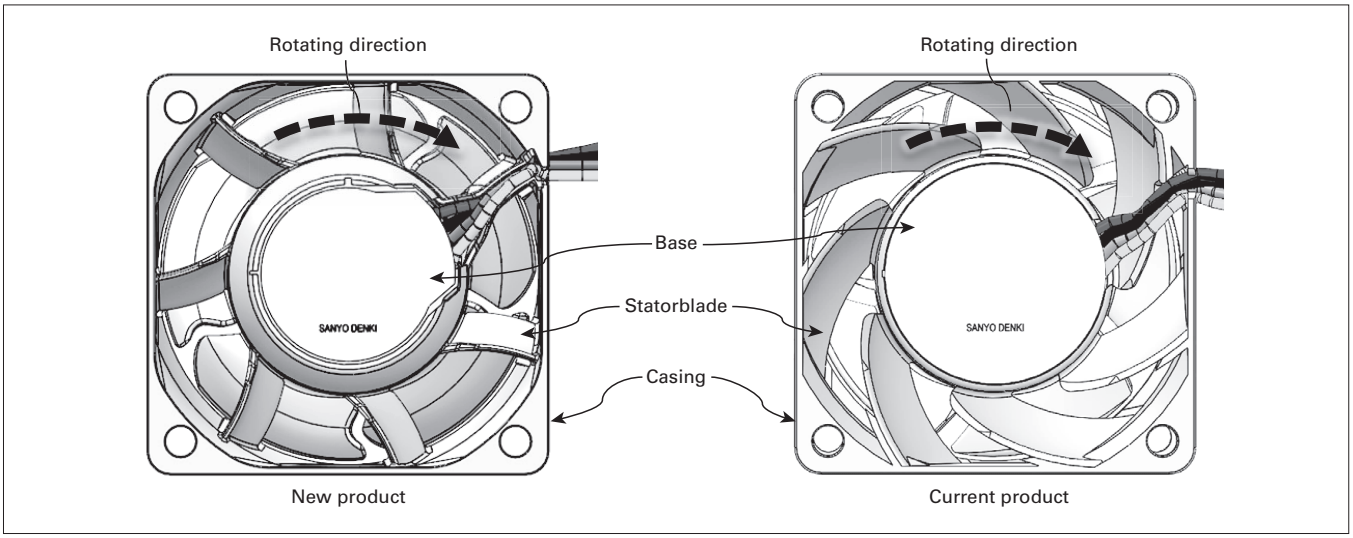

Fig. 4 Comparison between new and current products (outlet side)

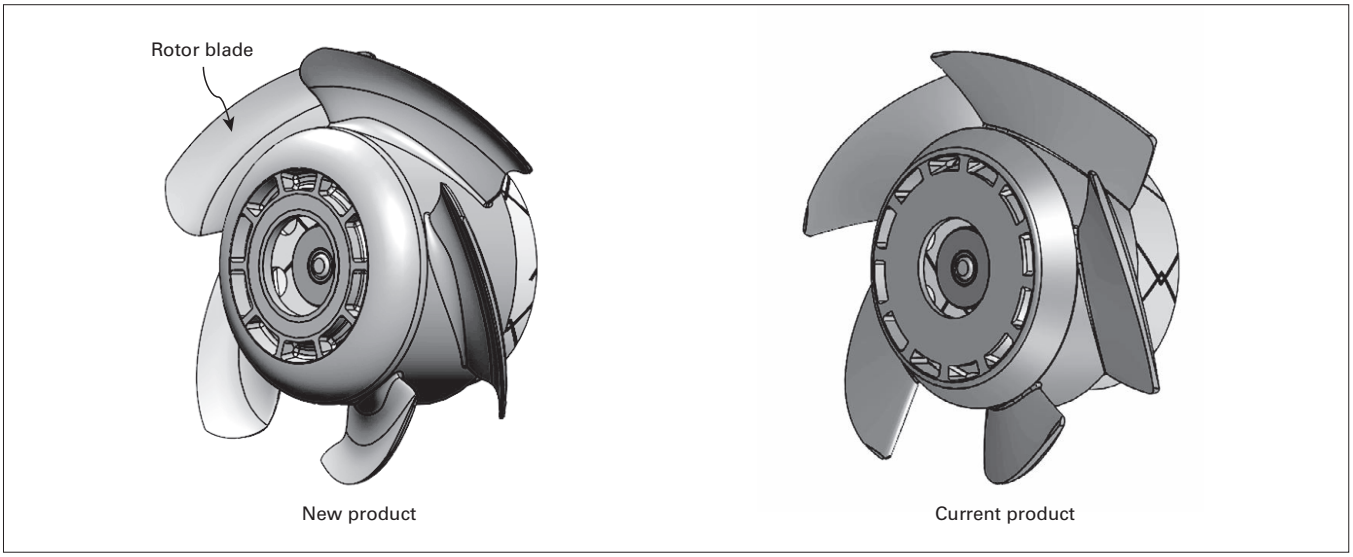

Fig. 5 Comparison of the impeller shapes for the new and current products

blade was designed to optimize the performance when the rotor and stator blades are combined.

In this way, we achieved a performance improvement from the current product by optimizing the shapes and combination of the rotor and stator blades.

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.

Airflow and static pressure have been improved 1.27 times and 1.14 times from the current product, respectively. This enables the new product to provide sufficient cooling performance for today's high-density and high-heat-generating devices.

5.2 Power consumption comparison with the current product at equivalent performance

Figure 7 compares the power consumption of the new and current products at equivalent cooling performance.

It shows that, when the fan speed of the new product is reduced using PWM control to match the cooling performance of the current product, the new product consumes about 20% less power in the estimated operating range, thus reducing the power consumption of equipment.

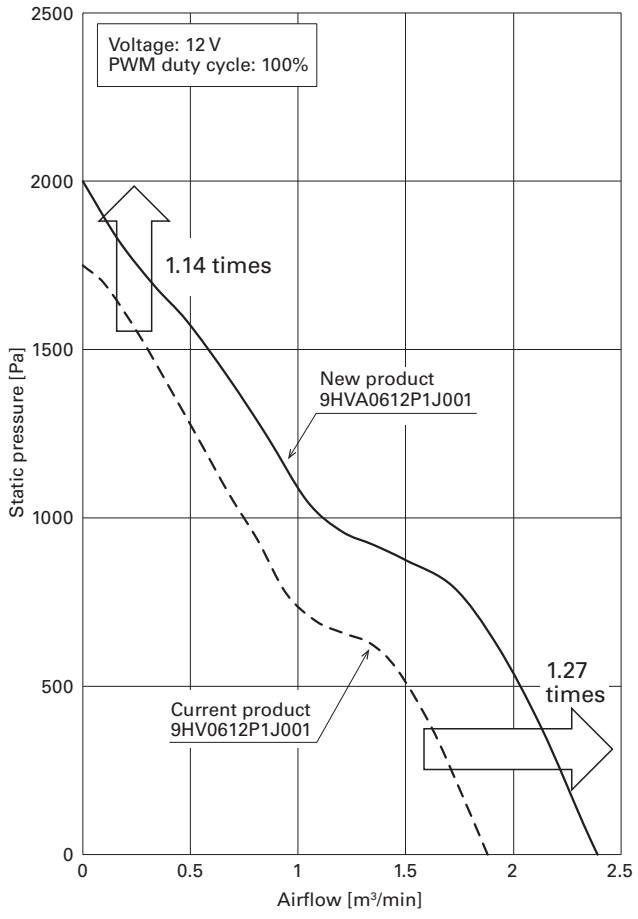

Fig. 6 Airflow vs. static pressure characteristics (Compared with the current product)

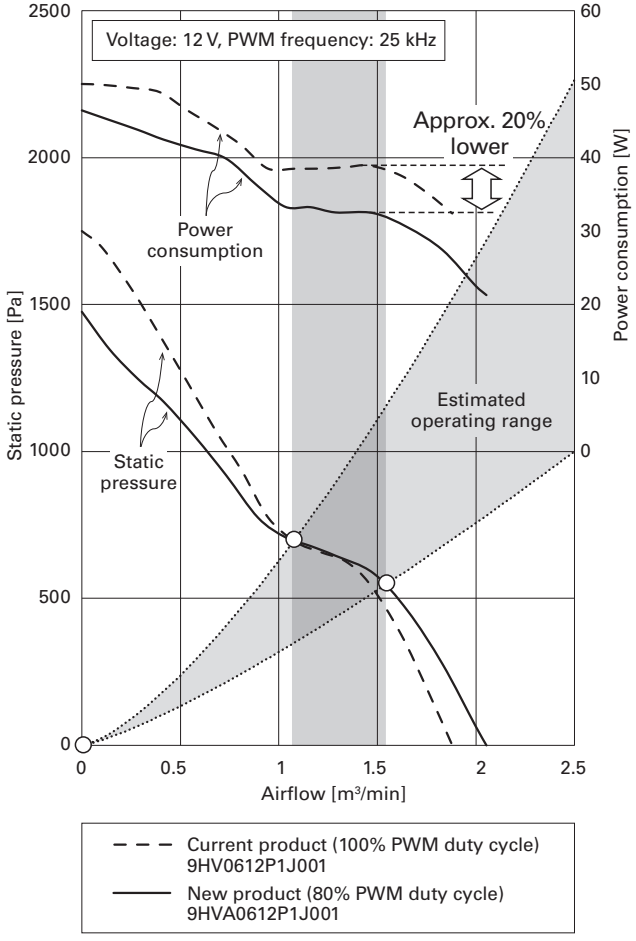

Fig. 7 Power consumption comparison with the current product

5.3 Noise level comparison with the current product at equivalent airflow

Figure 8 compares the noise level in free air in the airflow vs. static pressure characteristics shown in Figure 7.

It shows that, when the fan speed of the new product is reduced using PWM control to match the airflow of the current product, the new product produces 3 dB(A) less noise than the current product, reducing the noise of equipment.

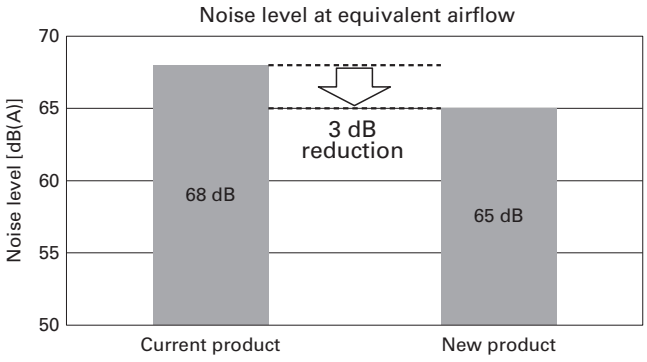

Fig. 8 Noise level comparison with the current product

6. Conclusion

This article has introduced the features and performance of the new 60 × 60 × 38 mm *San Ace 60* 9HVA type High Static Pressure Fan.

As the IT market continues to grow rapidly and the world moves toward a decarbonized society, there is a greater need for cooling fans with high performance and low power consumption like the new product.

In addition, as the market trend changes rapidly, it is expected that unprecedented and more diverse demands will be placed on cooling fans in the future. We will continue developing cooling fans to create new value in new and broad markets to meet the various needs of customers.

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The year 2021 was marked by the global pandemic of coronavirus disease 2019 (COVID-19). To prevent the spread of infection, human movement was restricted and this led to supply chain disruptions and production delays, which had a significant impact on people's lives and corporate activities.

In 2021, the Power Systems Division developed the following new products. The *SANUPS A11K-Li* uninterruptible power supply (hereinafter, "UPS") lineup has been expanded with the addition of a freezer-specific model. For UPS management, we developed a new web tool with added functions for *LAN Interface Card*. As for the engine generator category, we improved the *SANUPS M53A* truck type power generation vehicle.

This article provides an overview of each of these products.

■ *SANUPS A11K-Li* Lineup Expanded with the Addition of a Freezer-Specific Model

When COVID-19 vaccination programs rolled out in Japan in 2021, local governments unfamiliar with temperature control of medicines were responsible for vaccinations, and many citizens were concerned about the impact on vaccine vials if the power to freezers was cut off.

In response to such market requirements, SANYO DENKI added a freezer-specific model to the *SANUPS A11K-Li* lineup.

Freezers are equipped with a motor-driven compressor, which has a large inrush current at startup, and users often have a hard time choosing a UPS. The *SANUPS A11K-Li* freezer-specific model has sufficient overload capability and has been tested to have no problems in combination with the ultra-low-temperature freezer (deep freezer) designated by Japan's Ministry of Health, Labour and Welfare.

Also, adopting NEMA 5-15P as the input power plug enabled easy connection with standard wall AC outlets. Since NEMA 5-15P can handle a maximum current of 15 A, we added a safety feature that monitors output power, switches to battery operation, and stops the power supply from the wall AC outlet before the input current exceeds the specified value. This model is also equipped with casters for easy mobility from place to place.

The *SANUPS A11K-Li* freezer-specific model, with single-phase 2-wire 100 V input/output voltage and 1.5k VA/1.2 kW output capacity, is available in 100 and 200 standard backup times.

Fig. 1 *SANUPS A11K-Li* freezer-specific model

■ Development of HTML-Based Web Tool for *LAN Interface Card*

The *LAN Interface Card* comes with web tools that enable the UPS settings and the display of UPS status and measurement values using a web browser. Our conventional web tools used Java® (1), which have disadvantages including security vulnerabilities, the complexity of requiring an execution environment, and operational costs for these. Therefore, in recent years, many customers have demanded a safer, more reliable web tool with less restrictions.

Against this backdrop, we developed a new web tool that is based on HTML(2) with new functions.

This new web tool makes UPS management easier with an improved user interface with a tree style menu and resizable display window. In addition, it features enhanced monitoring functionality and a "simple setting wizard" that simplifies settings.

A separated article in this report provides the details of this new HTML-based web tool for *LAN Interface Card*.

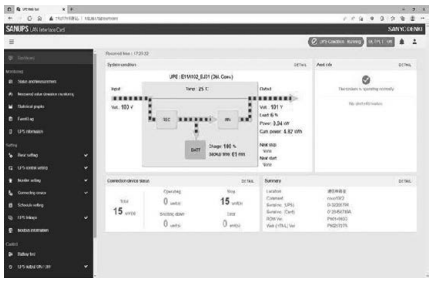

Fig. 2 Web tool screen

(1) Java is a programming language. It is capable of running independently of the hardware and operating system.
(2) HTML (Hyper Text Markup Language) is a markup language for creating web pages.

• Java is a registered trademark or trademark of Oracle Corporation.

■ Improvement of the *SANUPS M53A* Truck Type Power Generation Vehicle

The *SANUPS M53A* truck type is a 2-ton truck with a diesel generator, control panel, and fuel tank in a sound enclosure. Power generation vehicles need to be redesigned to comply with changes in environmental and safety requirements for the vehicles used, as well as revisions to related laws and regulations.

With our previous product, the power generator and vehicle shared the same fuel tank. However, the design has been reviewed to have separate fuel tanks to comply with the revised maintenance requirement in Japan's Road Transport Vehicle Act.

An emergency start-up function has also been added as part of this redesign. The exhaust vent on top of the sound enclosure is equipped with a safeguard that enables the power generator to run when the vent is fully open. Power generation vehicles are often used in times of natural disaster such as typhoons or heavy snow, and this feature enables the power generator to run after checking the exhaust vent conditions on site even if the generator is unable to run following a safeguard failure. By pressing the [WARNING STOP] button and [START] button for 10 seconds, the safeguard is canceled, enabling to start the operation.

The *SANUPS M53A* truck type comes standard with 3-phase 3-wire 210 V output voltage and output capacity of 100/125 kVA (50/60 Hz). Three-/single-phase switching and simultaneous output models are also available as options. The vehicle weighs less than 5,000 kg in total, and can be driven with a semi-mid-sized motor vehicle license.

Fig. 3 *SANUPS M53A* truck type

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HTML-Based Web Tool for *LAN Interface Card*

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1. Introduction

The *LAN Interface Card* is an optional product for our uninterruptible power supply (UPS). It comes with web tools developed using the Java programming language that enable users to view UPS status and measurement data as well as perform the *LAN Interface Card* settings on a web browser.

When we first developed these Java-based tools, the use of Java had the advantage of displaying screens with rich functionality without being affected by differences in web browsers. However, in recent years, an increasing number of customers have requested a new tool that does not use Java for the following reasons:

- Java vulnerabilities are frequently reported, and as such, there are concerns about security.
- To run an application developed in Java, a Java runtime environment must be installed to the computer.
- Commercial use of Java is not free of charge anymore.

Against this background, we developed a new web tool based on HTML (Hyper Text Markup Language) to meet these customer needs.

In this article, we provide an overview of the new HTML-based web tool for our *LAN Interface Card* (model no.: PRLANIF021A/22A/023A/024A).

2. Product Overview

The *LAN Interface Card*, when combined with our UPS, can monitor the UPS operating status and automatically shut down computers during prolonged power failures. Figure 1 shows the appearance of the *LAN Interface Card*.

Conventionally, we provided a Java-based Web Management Tool to configure shutdown operations and check the operating status history, and a Java-based Web Display Tool to graphically display the UPS operating status.

Fig. 1 *LAN Interface Card*

Our newly developed HTML-based web tool improves convenience by integrating the functions of both the existing Java-based Web Management Tool and Web Display Tool.

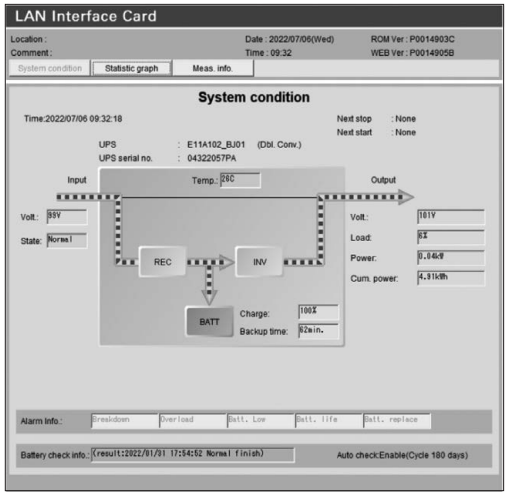
By developing the application using HTML, we were able to enhance security. In addition, it is now possible to send and receive files, which had been difficult with the previous Java-based applications. This improves convenience by enabling users to upload settings information and update programs and to download aggregated data and maintenance information.

Figure 2 compares screens of the existing and new web tools.

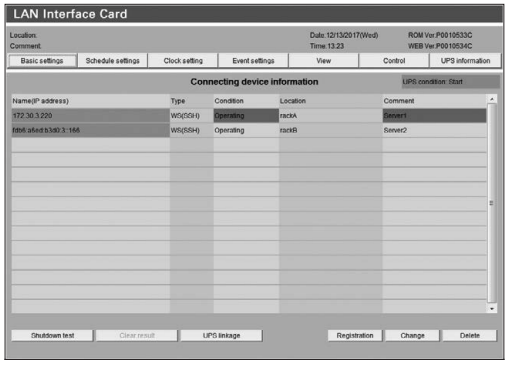
Existing web tool screen
(Java-based)

New web tool screen
(HTML-based)

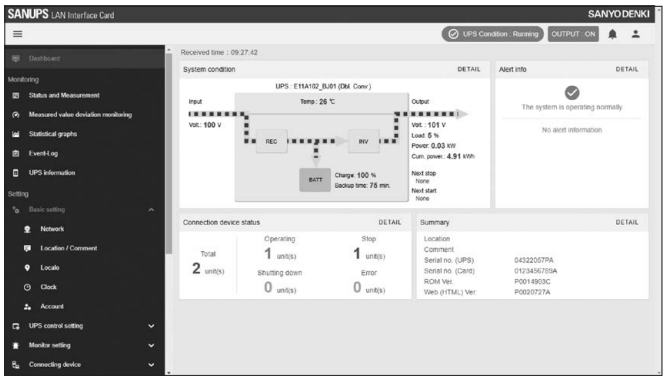
Web Display Tool screen



Web Management Tool screen



"Dashboard" page (homepage)



"Connecting device setting" page

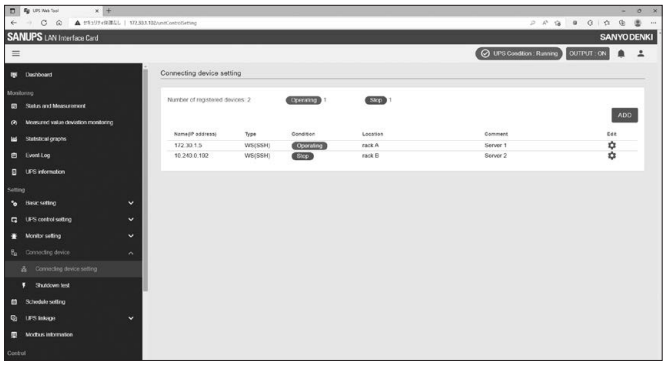


Fig. 2 Screens of existing and new tools compared

3. Features of the New HTML-Based Web Tool

3.1 Improved user interface

3.1.1 Multiple web tools integrated into one

We integrated the existing Web Management Tool and Web Display Tool into a single new web tool that enables management of all information, including settings and status monitoring.

3.1.2 Tree-style menu

The main menu was placed on the left side of the screen so that users can see at a glance what items are available for selection. This makes it easy for users to select the desired page.

3.1.3 Scale zoom-in and zoom-out functionality

The existing web tools have a fixed scale size, but the new web tool enables users to zoom in and zoom out the scale depending on the screen size. This enables users to resize the scale for easier viewing.

We also improved the user interface to provide greater convenience in managing UPSs, such as the ability to display the history of UPS status changes that occur while using the web tool.

Figure 3 explains the new web tool's Dashboard page.

3.2 Enhanced monitoring capabilities

3.2.1 UPS monitoring on the Dashboard page

Users can check the current UPS status at a glance on the "Dashboard" page, which is the homepage that is displayed when the new web tool is opened. The UPS power supply status is displayed graphically. In the event of a UPS problem, the details are displayed in the "Alert info" section of the page.

To view detailed information on "System condition," "Alert info," "Connection device status," and "Summary" (information such as serial number and program number), users can click "DETAIL" on each item on the "Status and Measurement" page and "Event-Log" page.

(Refer to Fig. 3 HTML-based web tool screen explained ("Dashboard" page))

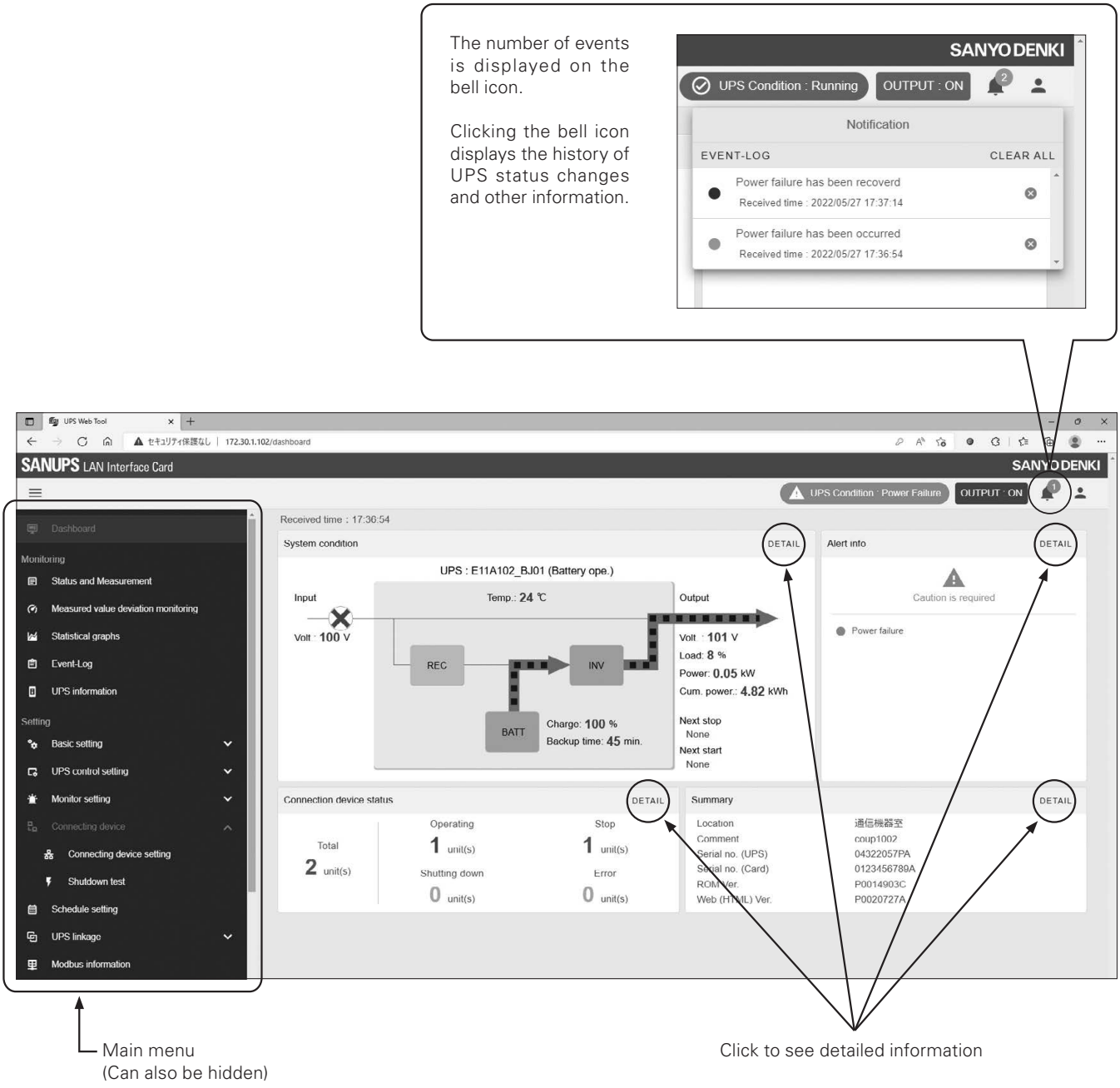


Fig. 3 HTML-based web tool screen explained ("Dashboard" page)

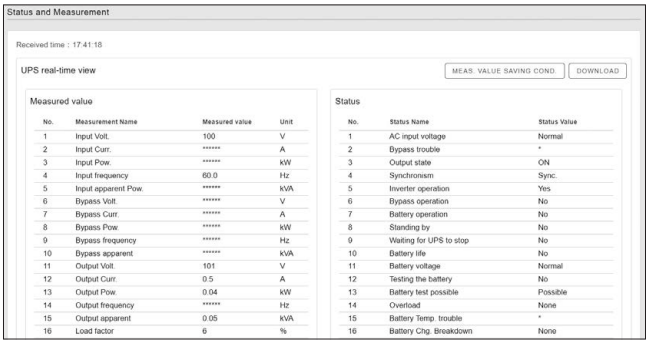
3.2.2 Measurement data aggregation and storage

On the "Status and Measurement" page, users can monitor the UPS status and measurements in real time, and by clicking the "DOWNLOAD" button, they can download and save collected measurement data as a file (in 10-second intervals, up to last 7 days). This data can be used for troubleshooting when needed.

On the "Statistical graphs" page, users can view the statistics of UPS measurements in graphs, and by clicking the "DOWNLOAD" button, they can download and save daily and monthly reports of the collected data as a file. This enables users to manage measurement information as a file.

Figure 4 shows "Status and Measurement" and "Statistical graphs" pages.

"Status and Measurement" page



"Statistical graphs" page

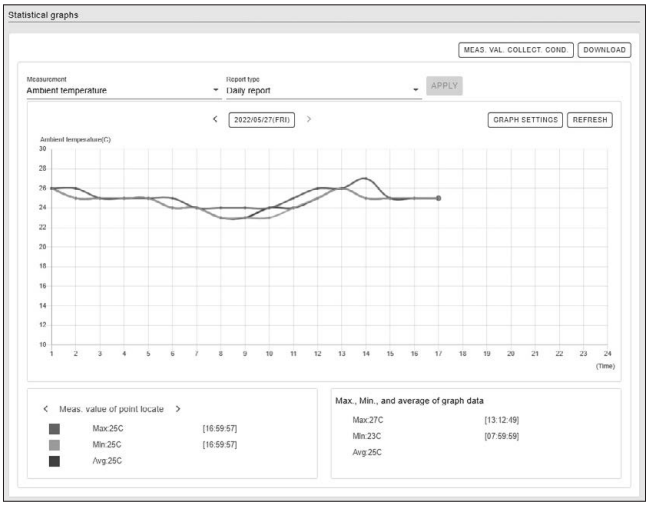


Fig. 4 "Status and Measurement" and "Statistical graphs" pages

3.2.3 Event log

On the "Event-Log" page, users can view the events that have occurred and the date and time of their occurrence. By clicking the "DOWNLOAD" button, users can download and save an event log of up to 1,000 events as a file.

Figure 5 shows the "Event-Log" page.

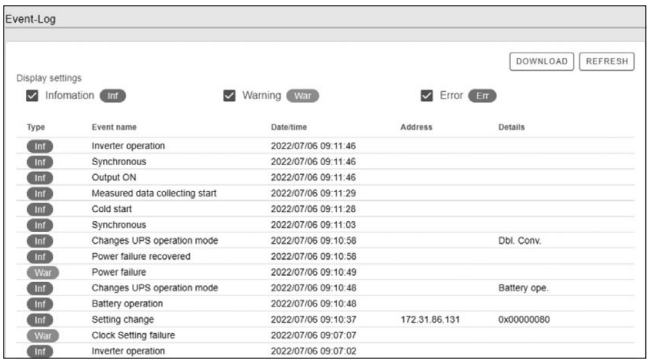


Fig. 5 "Event-Log" page

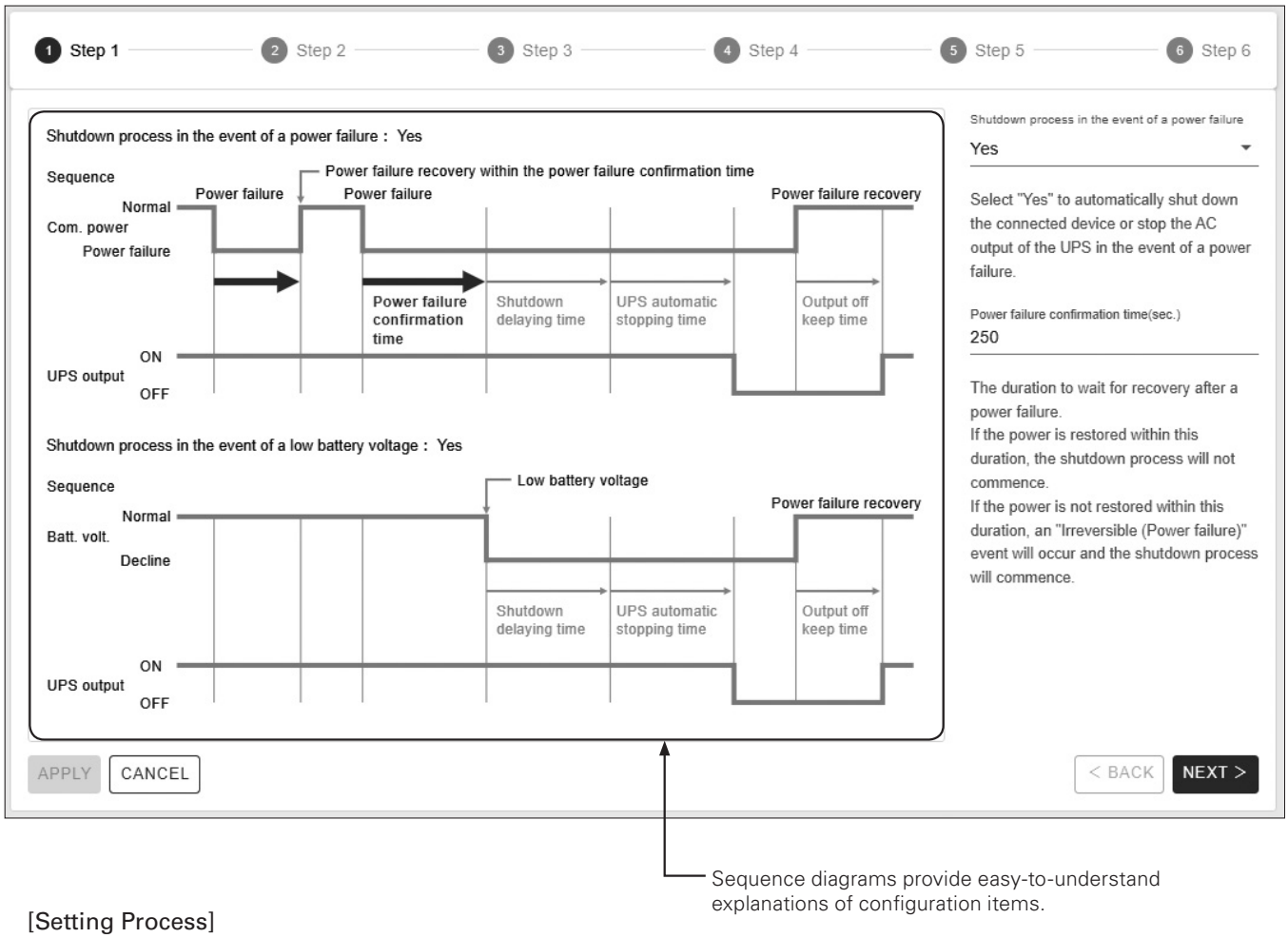
3.3 User-friendly settings

One of the main features of the *LAN Interface Card* is its ability to safely shut down computers in the event of a power failure. However, the UPS operation settings for shutting down a computer are complex and hard to understand for first-time users.

To it more intuitive, we created a "Simple setting wizard" to navigate users through the configuration steps in an easy and visual manner.

The "Simple setting wizard" navigates users through the configuration steps in order. This eliminates the chance of setting errors. In addition, by showing individual settings in a sequence diagram on the page, it makes it easier for first-time users to understand the configuration items.

Figure 6 shows the "Simple setting wizard" page.



Sequence diagrams provide easy-to-understand explanations of configuration items.

[Setting Process]

Step 1

- Shutdown process in the event of a power outage
- Confirmed outage time (s)

Step 2

- Shutdown process in the event of a low battery voltage
- Schedule to assume the low battery voltage when estimated backup time is under the specified value
- Specified value (min)

Step 3

- Shutdown delay time (s)

Step 4

- Automatic shutdown of the UPS AC output
- UPS automatic shutdown time (s)

Step 5

- Automatic start-up of the UPS AC output at power restoration
- Battery charging rate required for automatic start-up (%)
- Output off duration (s)

Step 6

- Confirmation of settings

Fig. 6 “Simple setting wizard” page

3.4 Increased maintainability

The following maintenance features are now available in the new HTML-based web tool. They make it easier for both users and us to maintain and manage UPSs.

- Download maintenance information
- Download/upload settings
- Update programs

3.4.1 Maintenance information available for download

Users can download maintenance information for troubleshooting from the "System information" page.

Maintenance information includes all information necessary for troubleshooting, such as UPS fault log, operator activity log, and event log.

In the event of an on-site problem, users can download maintenance information and send the downloaded file to us for immediate initial analysis without having a service technician coming on site.

Figure 7 shows the "System information" page.

Fig. 7 "System information" page

3.4.2 Download/Upload of settings

Users can download the *LAN Interface Card* settings from the "Setting download/upload" page.

In the event of on-site problems, users can send this configuration information together with the maintenance information to us, and by uploading it to our *LAN Interface Card*, we can reproduce the same operating environment as the user. This feature enables us to troubleshoot problems efficiently.

Figure 8 shows the "Setting download/upload" page.

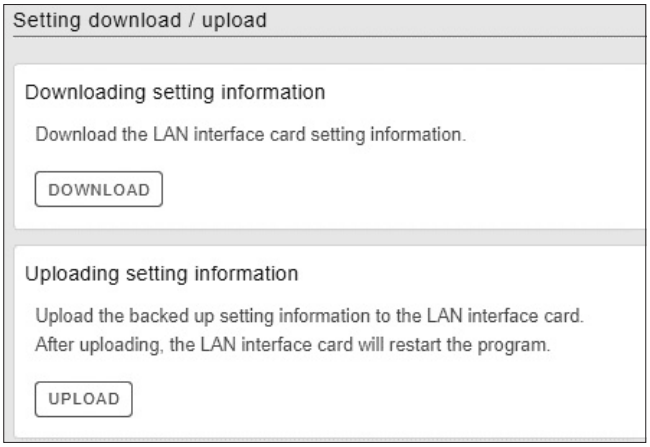


Fig. 8 "Setting download/upload" page

3.4.3 Program update

Whenever we update the *LAN Interface Card* software to enhance its features, we will publish the updated program on our website.

Updating the software can be completed on the "Program update" page in the new web tool, without using dedicated tools.

Figure 9 shows the "Program update" page.

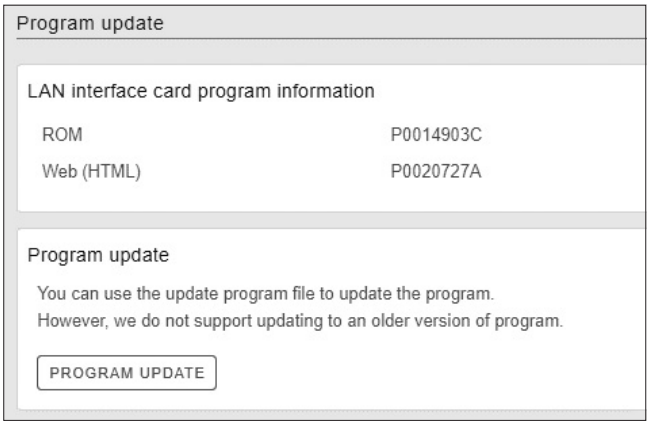


Fig. 9 "Program update" page

3.5 Enhanced security

The new web tool uses a secure encrypted protocol called Hypertext Transfer Protocol Secure (HTTPS) to provide customers with more secure service.

3.6 Java-based applications integrated

The new web tool integrates both the existing Java-based Web Management Tool and Web Display Tool, enabling users to continue using them if they wish.

4. Specifications

Table 1 lists the software requirements to use the new HTML-based web tool.

Table 1 Required software programs

Web browser	Operating system	Display language
Google Chrome	Windows	Japanese/English
Microsoft Edge (Chromium-based version)	Windows	Japanese/English
Mozilla Firefox	Windows/Linux	Japanese/English

Note: The supported web browsers listed above are the latest as of February 2022.

5. Conclusion

In this article, we introduced our new HTML-based web tool for the *LAN Interface Card*.

The new web tool can be used in environments without Java installed, enabling users to use it with peace of mind with fewer restrictions.

The new web tool for the *LAN Interface Card* is an indispensable tool that enables users to more easily manage their UPSs. Going forward, we will continue to develop products with user-friendly interfaces and enhanced features that meet customer needs.

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Servo Systems Division

Yasutaka Narusawa

SANYO DENKI contributes to society by developing new products that help enhance the performance and quality of our customers' equipment and create new value. This article introduces the features and innovations of the Servo Systems products we developed in 2021 and describes how they contribute to our customers and society.

These include stepping motors, servo motors, and motion controllers.

First, we have developed the *SANMOTION F* 56 mm sq. 2-Phase 1.8° stepping motors, expanding the product lineup of the series. This product achieved a 40% higher torque compared to our conventional products by shortening the air-gap length between the stator and rotor and adopting a magnet with high residual magnetic flux density. In addition, the noise level has been reduced by 3 dB by optimizing component shapes and engagement method and increasing the motor rigidity. The motor efficiency has also been improved by 3% by increasing the winding fill factor. With these improvements in performance and characteristics, the new product contributes to the downsizing, energy savings, and noise reduction of equipment.

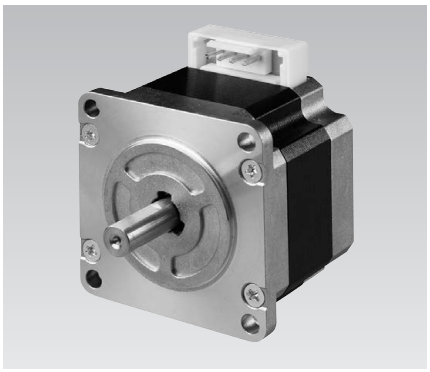
Next, we developed a highly reliable, compact, energy-efficient holding brake for AC servo motors. To improve brake reliability, we and a supplier jointly developed a new friction plate and updated the assessment criteria of environmental durability. This helped improving brake torque stability even in environments with severe temperature and humidity changes. The brake wear rate due to idling wear has been reduced by half, further increasing reliability. Moreover, we achieved downsizing and lower power consumption with a new structure where the motor and brake are integrated into one unit and optimization of electromagnetic field. This new holding brake can improve the safety and reliability of equipment, as well as contribute to size reduction and energy savings.

In the field of linear motors, we developed a *SANMOTION* multi-axis integrated linear servo motor unit. This product achieves a high thrust thanks to its optimized magnetic circuit. The bobbin structure was devised with denser winding and reduced copper loss, resulting in reduced heat generation. In addition, we designed the linear motion guiding apparatus to suppress friction fluctuations during operation so that the settling performance would be more uniform. This product can simplify the structure of customer equipment thanks to its multi-axis integrated design. With increased thrust and improved settling performance, it can also contribute to improving the performance and productivity of those equipment that requires fast repetitive motion, such as surface mounters.

In the field of robot motion control, we developed the *SANMOTION C S500* motion controller. This product can control robots of various configurations, including cutting-edge 7-axis articulated robots, and its robot communication cycle is eight times faster than that of our conventional product. With a variety of open networks supported, the controller can communicate with network devices in real time and can help make factories automated and IoT-ready. In addition, the new controller has been downsized to 30% of the conventional product. It features a much smaller size, improves the performance of customer equipment, and helps make customer systems IoT-ready by enabling features such as predictive maintenance using various data.

Below are the overview of these new products with their features.

■ *SANMOTION F* 56 mm sq. 2-Phase 1.8° Stepping Motor



The new *SANMOTION F* 56 mm sq. 2-Phase 1.8° stepping motor has about 40% higher motor torque as well as lower noise and higher efficiency than our conventional product. We also enhanced the lineup of its options.

The features of this product are introduced below.

1. High torque

The air-gap length has been reduced by 28% compared to the conventional product by improving the processing precision of components such as the stator and rotor, as well as by making improvements in motor assembly processes to increase the motor assembly precision. In addition, adopting a magnet with high residual flux helped increase the amount of magnetic flux in the air gap, resulting in 40% higher torque while maintaining the same overall motor length as the conventional product.

2. Low noise

The rigidity of the stator core has been increased by performing structural analysis and revising the shapes of the back yoke and pole. For the motor rigidity, on the other hand, the tightening allowance and engagement length between the bracket and stator have been optimized to improve the rigidity after assembling while keeping the ease of the motor assembly. This reduced the noise level by 3 dB in the operating speed range.

3. Energy saving

The copper loss has been reduced by increasing the winding fill factor within a slot. In addition, the total loss has been reduced by optimizing the core design to reduce iron loss and improved the motor efficiency by approximately 3%. These loss reductions and higher torque enabled to achieve equivalent torque to the conventional products with less input current, contributing to reducing heat generation in the equipment and energy savings.

4. Customizability and a wide lineup of options

Like the conventional product, the new product is designed for easy customization, including changing the shaft shape and adding tapped holes to the bracket. The lineup also includes models with low-backlash gears and harmonic gears, models with encoders, and models with electromagnetic brakes, providing a full range of options.

This wide lineup of options allows customers to configure custom products to best suit their equipment and provides customers with a greater degree of freedom in designing their equipment.

■ Holding Brake (for AC Servo Motors)

In recent years, industrial robots have become increasingly popular in Japan to improve productivity at manufacturing sites in response to the shrinking workforce due to the declining birthrate and aging population. Against this backdrop, we developed a highly reliable holding brake (for AC servo motors) for use with industrial robots.

Its features are as follows.

1. Expanded lineup

To provide a greater selection of products suitable for customer equipment, we expanded our lineup of brakes for small-capacity, high-power motors with the addition of 11 holding brakes with 0.48 to 16 N m torque for use with 40 to 130 mm AC servo motors.

2. High reliability

We set new environmental durability assessment criteria and jointly developed a new friction plate with one of our supplier. This improved brake torque stability in high-temperature and high-humidity conditions. The brake wear rate due to idling wear has also been reduced by half, further enhancing reliability. These improvements allow it to be used safely even in equipment operated near people.

3. Size reduction

The new brake-integrated motor structure and optimized electromagnetic field have achieved downsizing. The overall length of the holding brake for 130 × 130 mm motors has been shortened by 13 mm compared to our conventional brake, achieving a significant size reduction. This gives more space in customer equipment for downsizing, providing a greater degree of design freedom.

4. Low power consumption

The power consumption has been reduced by up to 44% compared to the conventional brake by optimizing the electromagnetic field, providing reduced power consumption and allowing power supplies to be downsized for customer equipment.

■ Multi-Axis Integrated Linear Servo Motor Unit

In equipment such as semiconductor manufacturing equipment and various automated assembly machines, multiple servo motors are often installed to the vertical moving Z-axis for pick-and-place applications. In addition, many types of equipment use small linear motors to shorten the cycle time and improve the productivity of the equipment.

To meet such needs, we developed the *SANMOTION* multi-axis integrated linear servo motor unit where multiple compact cylinder linear motors are integrated into one unit.

Its features are as follows.

1. High thrust and lower heat generation

The magnetic circuit structure with optimized magnet dimensions and back yoke shape increased the effective magnetic flux and the motor thrust. Also, this product generates less heat by using a new bobbin structure with less winding problems for denser winding and reduced copper loss.

2. Uniform settling performance

The motor has ball splines and linear bushings installed in the linear motion guiding apparatus, improving the straightness of the moving shaft and reducing frictional thrust. This helps reduce disturbances caused by friction fluctuations during operation and provides uniform settling performance.

3. Multi-axis integrated unit

When customers would mount multiple conventional single-axis linear motors to their equipment, they had to mount individual motors and make necessary adjustments, which was time consuming and cumbersome. The new product comes standard as a 4-axis integrated unit and the motor number and size can be customized tailored to customer equipment. This facilitates the motor mounting and simplifies the structure of their equipment as well.

The number of axes and the pitch between axes are also customizable to suit customer requirements.

■ *SANMOTION C S500* Robot Motion Controller

In recent years, robots have been increasingly deployed in various industries in response to the labor shortage due to the declining birthrate and aging population in Japan. In the manufacturing industry, the robot introduction has automated assembly and conveyance processes, greatly contributing to improving equipment productivity. There is also a growing demand for autonomous robots in the logistics and service industries, requiring controllers capable of controlling various robots.

To meet these market demands, we developed three robot motion controllers: a compact standard model capable of controlling a wide range of robots with functions required for next-generation robots, a mid-range model, and a high-end model for equipment on large-scale production lines.

Its features are as follows.

1. Various robot control functions

This motion controller can control cartesian, horizontal articulated, delta, palletizing, and 6-axis articulated robots, as well as cutting-edge 7-axis articulated robots.

Functions such as trajectory control and interpolated operation can be done with ease as the controller is equipped with various robot commands, contributing to in-house robot motion planning.

2. Improved control performance

The new product has a robot communication cycle that is eight times faster than the conventional products, improving the productivity and performance of customer equipment. In addition, a single motion controller can control up to four robots, reducing the cost of building robotic systems.

3. Enhanced network functions

The controller's interface supports various open networks such as EtherCAT, Modbus TCP, various PLC communication protocols, and OPC UA to help make factories automated and IoT-ready. This product can provide equipment diagnosis and preventive maintenance by sharing information with various devices in real time.

4. Shortened development time

This product features 3D robot motion simulation functionality that enables users to visually check the program behavior and robot status on a computer. The interactive user interface functionality has been expanded to enable users to set controller and robot parameters simply by selecting the equipment to use. These functions aid customer program development and shorten the development time of customer equipment.

5. Reduced size and weight

The size and weight of the new product are only 30% and 37% of that of the conventional product, respectively, allowing it to mount in a limited space and downsize customer equipment.

Details on *SANMOTION C S500* are covered in a separate article in this Technical Report.

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Development of the *SANMOTION C* Robot Motion Controller

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1. Introduction

In recent years, robots have been increasingly deployed in various industries to solve the labor shortage due to the declining birthrate and aging population in Japan. The robot introduction into production processes has automated production equipment and improved productivity through labor savings. To maintain high productivity with robots, it is important to quickly detect and respond to changes in the operating environment and production equipment with which robots are used. Therefore, robot controllers need to have advanced motion control functions as well as information communication functions that can grasp production status in real time and transform and transmit relevant data.

To meet this need, we have developed a robot motion controller that features various robot control functions, as well as enhanced capabilities for communicating with ICT equipment.

In this article, we describe the main functions and features of the new robot motion controllers added to the *SANMOTION C* lineup.

2. Product Overview

The product lineup was expanded with the addition of three models: a standard model 505 (hereinafter, “505”) for single robot control, and mid-range model 507 (hereinafter, “507”), and high-end model 520 (hereinafter, “520”) for multi-robot control.

2.1 Appearance and dimensions

Figure 1 shows the appearance of the 520, 507, and 505 robot motion controllers. Figure 2 shows the dimensions of the 520 model, while Figure 3 shows those of the 507 and 505 models.

These come with a DIN rail for easy installation to a control panel.

Fig. 1 520 (left), 507, and 505 (right)

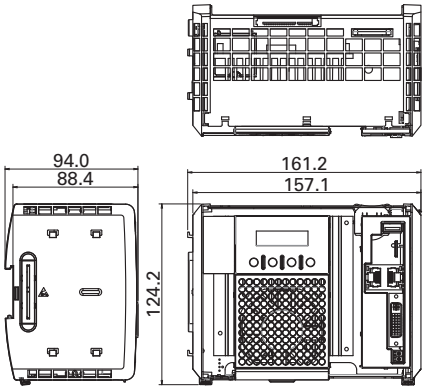

Fig. 2 Dimensions of the 520

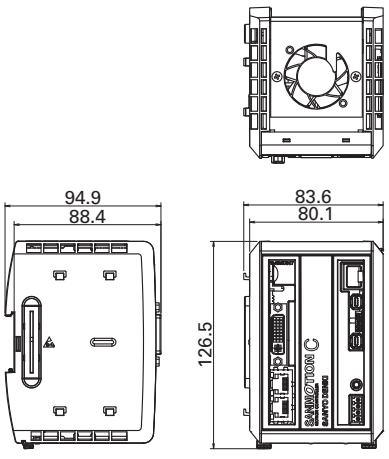

Fig. 3 Dimensions of the 507 and 505

2.2 General specifications

Table 1 shows the general specifications of the new models.

Each model comes standard with an EtherCAT industrial open network interface to support motion networks. The high-speed EtherCAT enables real-time monitoring of equipment status. These models have Ethernet, RS-232, RS-422, RS-485, and USB interfaces, and also support open protocols such as OPC-UA, Modbus TCP, HTTP, and MQTT, making them compatible with various devices.

These models comply with the following international standards: UL/cUL (North America), EMC Directive (Europe), UKCA (United Kingdom), and KC Mark (South Korea).

Table 1 General specifications

Model		High-end	Mid-range	Standard
Model no.		SMC520	SMC507	SMC505
Interface		EtherCAT (100 Mbps) master function		
		Ethernet (10/100/1000 Mbps) × 2 ports Protocol (Modbus TCP, OPC-UA)		
		–	RS-232/422/485 × 1 port	
		USB 3.0 × 1 port USB 2.0 × 1 port	USB 3.0 × 1 port	
Input voltage		24 VDC (19.2 to 30 VDC)		
Power consumption (of controller) [W]		33.7	28.2	17.7
Dimensions (W x H x D) [mm]		161.2 × 124.2 × 94	83.6 × 126.5 × 94.9	
Mass [g]		900	515	500
No. of controllable robots		4	2	1
Control functions		Sequence/motion/robot control		
Compliance with standards	UL/cUL	UL 61010-1, UL 61010-2-201		
	EMC Directive	Directive 2014/30/EU		
	RoHS Directive	Directive 2011/65/EU		
	UKCA	BS EN 61131-2:2007		
	KC Mark	KN 61000-6-2, KN 61000-6-4		

Note: "SMC" is omitted in the model no. in the running text.

3. Main Functions

In addition to robot control functions, the new models come equipped with sequence control and motion control functions, enabling you to develop a robot system with a single controller. In particular, a dedicated teaching pendant and robot commands allow for easy robot motion planning and teaching tasks. The details of each function are provided below.

3.1 Motion control functions

The new models not only feature a digital I/O-based sequence control, but also PTP positioning and electronic cam (for multi-axis synchronization) functions. As shown in Table 2, they can control up to 64 motor axes and support programming languages compliant with IEC 61131-3.

Table 2 General motion control specifications

No. of controllable axes	Up to 64
Communication cycle	1 to 16 ms
Control system	Position control, speed control, torque control
Acceleration/ deceleration profile	Trapezoidal, sine squared, and trapezoidal with jerk limit
Unit for positioning control	Arbitrary (pulse, mm, inch, degree)
Programming languages	IL, ST, LD, FBD, SFC, and CFC as per IEC 61131-3
Motion function block	Homing, incremental mode, absolute mode, constant speed mode, electronic cam, and electronic gear

3.2 Robot control functions

As shown in Table 3, the new models are equipped with kinematics tailored to robot mechanisms, enabling a single controller to control up to four robots. The new models can perform robot jog operations and 3D interpolation control using a dedicated teaching pendant and robot commands. These functions make it possible to program robot motion in a short period.

Table 3 General robot control specifications

No. of controllable robots	Up to 4
Communication cycle	1 to 16 ms
Control system	PTP motion, 3D linear interpolation, and 3D circular interpolation
Control functions	Conveyor tracking, palletizing (without teaching) Collision detection
Teaching method	Numerical input or through teaching
Unit for positioning control	Arbitrary (pulse, mm, inch, degree)
Programming languages	Original language
Controllable robot mechanisms	Cartesian coordinate, SCARA, parallel link, palletizing, and 6-/7-axis articulated robots

3.3 Collision detection

To enhance the safety and reliability of robot systems, the new models are equipped with a function that detects robot collisions and performs robot emergency stops prior to any alarms such as servo amplifier overloading. The collision is detected by comparing joint torque values calculated from the robot's motion profile with the robot's torque sensor values. This function support SCARA robots.

3.4 Integrated development tool (*SANMOTION C* Studio)

The integrated development tool features a tree-style menu to centrally manage the configurations, programming, and 3D simulations required in robot development processes.

3.4.1 Configuration functions

Figure 4 shows the screen of the interactive user interface for setting the devices that configure the robot. Users can set system (controller and servo amplifier) parameters by simply selecting devices through dialogs. Figure 5 shows the configuration screen for setting robot mechanism parameters. This graphically displays robot mechanisms and enables you to set parameters intuitively.

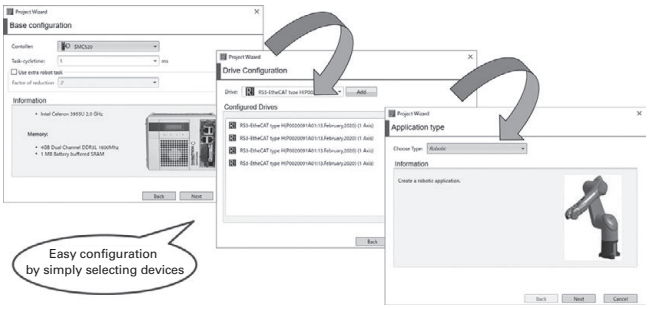

Fig. 4 Dialog-based user interface

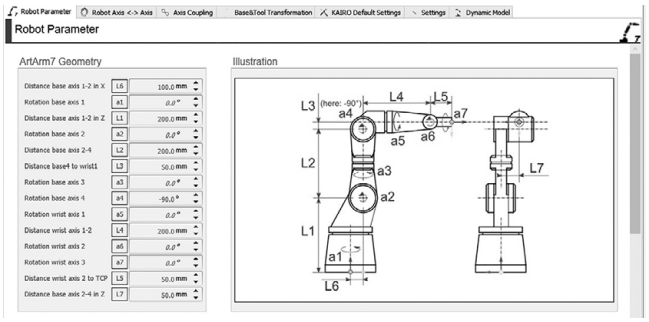

Fig. 5 Configuration screen

3.4.2 Programming functions

Figure 6 shows the screen for creating an application program for sequence and motion control. The tool provides programming languages that comply with the international standard IEC 61131-3, including IL (instruction list), LD (ladder diagram), ST (structured text), SFC (sequential function chart), FBD (function block diagram), and CFC (continuous function chart). You can create robot motion programs using a teaching pendant and the development tool shown in Figure 7. This environment makes it easy for PLC programmers and robot engineers to develop programs, and shortening the robot system development time.

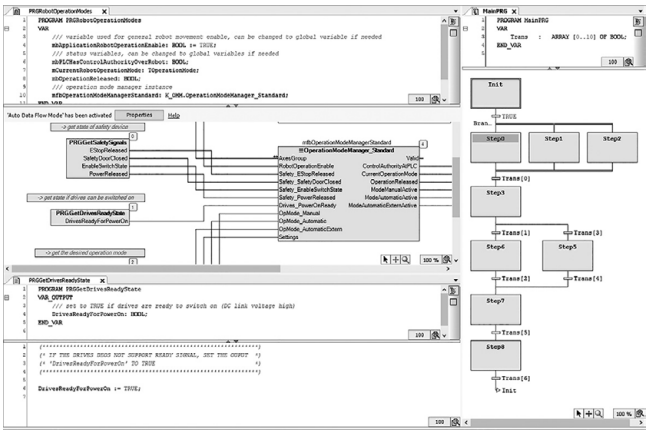

Fig. 6 Motion control programming screen

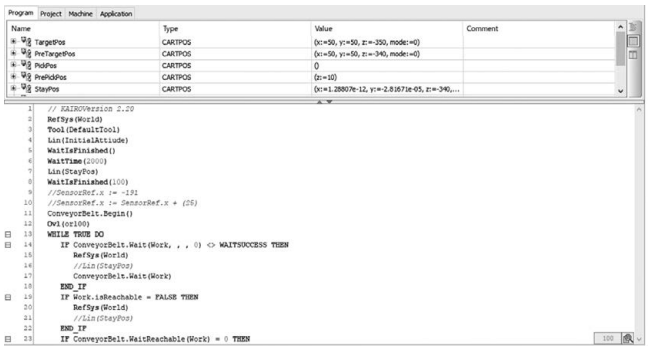

Fig. 7 Robot control programming screen

3.4.3 3D simulation functions

The tool comes with the 3D simulation function shown in Figure 8 that enables you to visually check the robot motion with its corresponding programs before putting them into actual use.

You can check how robots move under the set configuration parameters and programming logic on a computer. This greatly reduces the labor hours required for robot development.

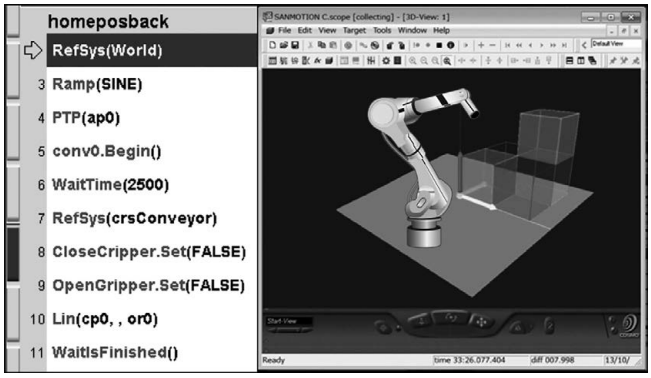

Fig. 8 3D simulation screen

4. Product Features

4.1 Size reduction

As shown in Table 4, the volume has been reduced by 70% compared to the current models by reducing the PCB size through high-density mounting of electronic components. This contributes to space savings in the control panel.

Table 4 Size comparison with the current product

Item	New product		Current product
Model no.	SMC520	SMC507, SMC505	SMC263X, SMC265X
Dimensions (W x H x D) [mm]	161.2 × 124.2 × 94	83.6 × 126.5 × 94.9	270 × 120 × 100
Volume [cm^3]	1,882	1,004	3,240

Note: "SMC" is omitted in the model no. in the running text.

4.2 Abundant robot control

As shown in Figure 9, the new models can control 15 robot configurations, including the industry's cutting edge 7-axis articulated robots. The 7-axis articulated robots can move their arms like humans, avoid obstacles, and automate complex tasks in limited spaces. The new models enable users to perform various types of robot trajectory control and interpolated motions simply by setting robot mechanism parameters, contributing to in-house robot motion planning.

4.3 Enhanced network functions

Figure 10 shows a network configuration example.

The new models feature Ethernet-based OPC-UA and Modbus TCP communications for sharing data with production management systems. OPC-UA is a communication protocol that is not manufacturer or device-dependent. Additionally, the built-in Modbus TCP, an open protocol, improves compatibility with touch panel displays, image processing equipment, and other peripheral devices. Also, using EtherCAT for the motion network enables to connect to all devices via an Ethernet cable, contributing to reducing system costs.

Furthermore, the new models can store data collected from production equipment on servers using HTTP and MQTT communications. By analyzing the stored data, you can predict degradation and errors in production equipment in advance and perform maintenance before failures or malfunctions occur.

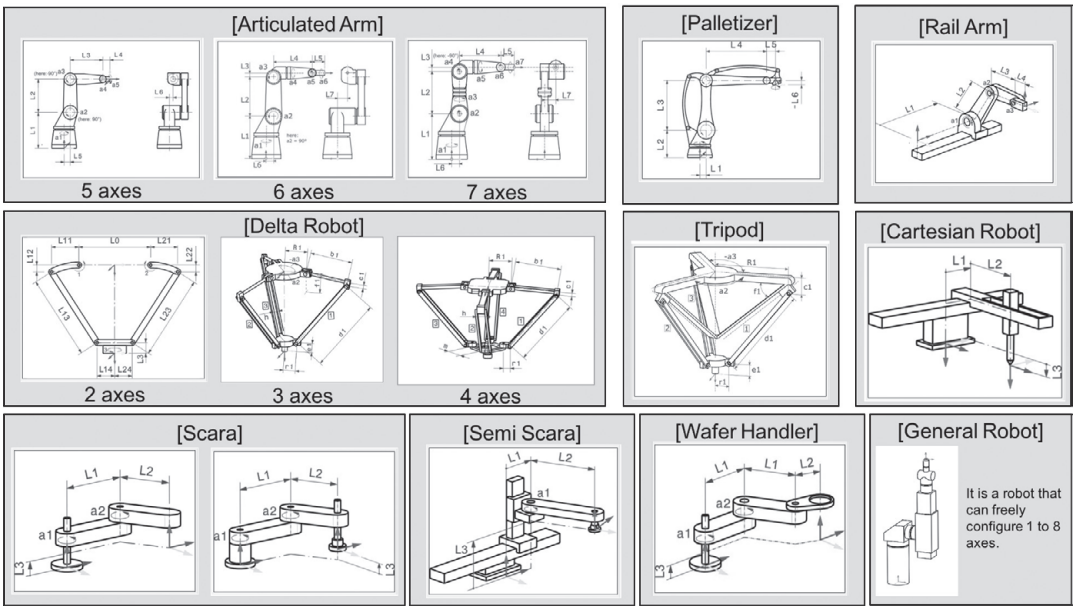

Fig. 9 Controllable robot mechanisms

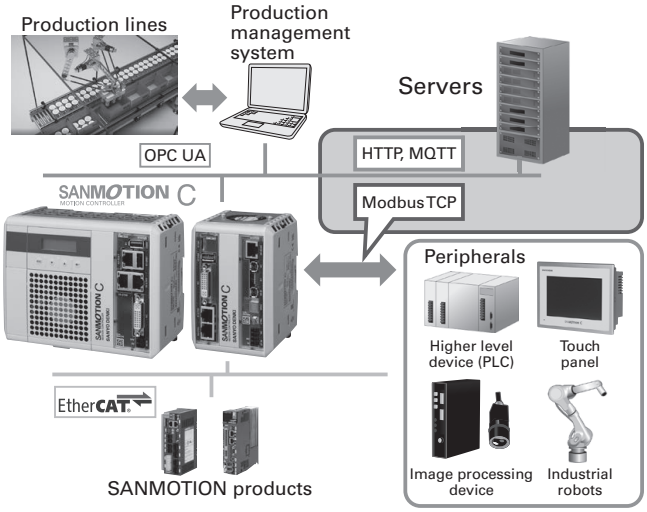

Fig. 10 Network connection configuration

5. Conclusion

In this article, we described the main functions and features of our new *SANMOTION C* lineup of robot motion controllers that contribute to automating production equipment and improving productivity through labor savings.

(1) The new models can control 15 robot configurations, including the industry's cutting-edge 7-axis articulated robots, contributing to the in-house robot motion planning for various industries.

(2) The new models support various communication protocols, such as Ethernet-based OPC-UA, Modbus TCP, HTTP, and MQTT, that improve compatibility with production management systems, peripheral devices, and servers.

(3) The new models come with enhanced network functions that enable real-time monitoring of production equipment operations. This enables users to detect changes in production equipment as quickly as possible and perform maintenance before failures or malfunctions occur.

The new models provide real-time monitoring of operations and contribute to high-quality manufacturing through their robot control functions and ICT equipment communication functions.

Going forward, we will continue to develop products with features that meet market demands so that we can create new value for our customers.

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List of Awarded and Nominated Engineers for the 70th JEMA Technological Achievement Award in 2021

Heavy Electrical Category			
Prize	**Title**	**Department**	**Name**
Encouragement Award	Development of 40 × 40 × 28 mm High Static Pressure Fan	Design Dept., Cooling Systems Div.	Toshiyuki Nakamura, Katsumichi Ishihara, Atsushi Yanagisawa, Shuji Miyazawa, Hikaru Urushimoto
Encouragement Award	Development of Lithium-Ion Battery UPS with Parallel Redundancy	Design Dept., Power Systems Div.	Hiroshi Sakaba, Akihiro Tsukada, Kazuya Nishizawa
Encouragement Award	Development of *SANMOTION R* 400 VAC Input Multi-Axis Servo Amplifier (37 kW)	Design Dept. 2, Servo Systems Div.	Noriaki Kasuga, Mitsuru Takasugi, Hiroto Noguchi, Masaaki Mizusawa, Satoshi Hiramitsu, Shuhei Nakazawa
Encouragement Award	Building of Automated Servo Amplifier Inspection Line	Servo Systems Div., Production Engineering Dept.	Shusaku Magotake, Yoshinari Furusawa, Hiroshi Yanagisawa, Shota Kasuga
		Design Dept. 2, Servo Systems Div.	Hideo Miyazawa
Encouragement Award	Flicker Solution with Standard Islanding Detection Method for 3-Phase PV inverters	Design Dept., Power Systems Div.	Hiroshi Yamada

Department names are those at the time of nomination.

Major Patents

■ **Patents registered in 2021**

Patent Number	Title	Inventor(s)
U.S. - 10985642	POWER TRANSMISSION DEVICE	Satoshi Sugita, Yuqi Tang, Yasushi Misawa, Shigenori Miyairi
Germany - 102014109469	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Satoshi Yamazaki
China - ZL201610017811.1	MOTOR CONTROL APPARATUS	Yuji Ide, Takao Oshimori, Hiroaki Koike
China - ZL201610076504.0	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
Philippines - 1-2016-000293	MEASUREMENT DEVICE	Katsumichi Ishihara, Takahisa Toda, Yo Muramatsu, Masahiro Koike, Hikaru Urushimoto
China - ZL201610772710.5	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
Philippines - 1-2016-000310	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
Taiwan - I725053	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
China - ZL201610770901.8	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
Taiwan - I730000	MOTOR CONTROL APPARATUS	Yuji Ide, Michio Kitahara, Toshio Hiraide
Taiwan - I725042	MEASUREMENT DEVICE	Masahiro Koike, Tomoaki Ikeda, Takahisa Toda, Yo Muramatsu, Katsumichi Ishihara, Hikaru Urushimoto
Taiwan - I717424	MOTOR CONTROL APPARATUS	Yuji Ide, Toshio Hiraide
Taiwan - I738694	MOTOR	Manabu Horiuchi, Toshihito Miyashita
China - ZL201710220320.1	MOTOR	Manabu Horiuchi, Mai Shimizu, Jun Kitajima
Taiwan - I738814	MOTOR CONTROL APPARATUS	Yuji Ide, Toshio Hiraide, Keigo Kikuchi
Japan - 06849366	REVERSIBLE FLOW FAN	Yoshihisa Yamazaki
Taiwan - I727094	REVERSIBLE FLOW FAN	Yoshihisa Yamazaki
China - ZL201710831289.5	BLAST FAN	Yoshihisa Yamazaki, Satoshi Fujimaki, Takashi Kawashima, Soma Araki
Japan - 06830791	LINEAR MOTOR	Yuqi Tang
Japan - 06846213	MOTOR CONTROL APPARATUS	Yuji Ide, Toshio Hiraide, Michio Kitahara
Japan - 06877194	DEVICE AND METHOD FOR DISPLAY OF INFORMATION ABOUT SETTING/STATUS OF POWER SUPPLY MANAGEMENT DEVICE	Katsuhiro Yoshizawa, Yutaka Kato, Kiyoshi Mizuguchi
Japan - 06924068	PARALLEL-CONNECTED STORAGE BATTERY SYSTEM AND CONTROL DEVICE THEREOF	Minoru Yanagisawa, Takashi Kobayashi
China - ZL201810461562.4	FAN MOTOR APPARATUS AND METHOD FOR MANUFACTURING THE SAME	Naoya Inada, Masato Kakeyama, Atsushi Yanagisawa
U.S. - 10951082	STATOR OF ROTATING ARMATURE AND ASSEMBLY METHOD THEREOF	Mitsuaki Shioiri, Koji Nakatake, Yasushi Yoda, Hong Zhang, Kazuhiro Yoda, Shogo Yoda
U.S. - 11041498	FAN MOTOR APPARATUS AND PROTECTION COVER OF FAN MOTOR APPARATUS	Yusuke Okuda, Haruhisa Maruyama, Yoshihisa Yamazaki
Japan - 06830996	FRAME STRUCTURE OF MOTOR AND METHOD FOR MANUFACTURING FRAME AND ARMATURE OF MOTOR	Manabu Horiuchi, Yasushi Misawa, Jun Kitajima, Mai Shimizu
Japan - 06827098	ROTATING ELECTRIC MACHINE	Manabu Horiuchi, Mai Shimizu, Takashi Matsushita, Yasushi Misawa

Internal Recognition: Invention Excellence Award

Awarded in May 2021

Prize	Title	Department	Name
Excellence Award	Detection of Motor Insulation Resistance	Design Dept. 2, Servo Systems Div.	Yuji Ide
		Under Operating Officer for Administration	Keigo Kikuchi
		Design Dept. 2, Servo Systems Div.	Toshio Hiraide, Masakazu Sakai
Excellence Award	Motor Controller Mounting Structure	Design Dept. 2, Servo Systems Div.	Yuji Ide, Takao Oshimori, Hiroaki Koike

Internal Recognition: Manufacturing Excellence Award

Awarded in May 2021

Prize	Title	Department	Name
Excellence Award	In-Mold Gate Cutter Design for Large Fan Molds	Engineering Sect. 2, Production Dept. Production, Cooling System Div.	Shinsuke Okubo, Yoichi Yamada
Excellence Award	Development of High Fill Factor Winder for DC Servo Motors	Production Engineering and Development Sect., Production Engineering Dept., Servo Systems Div.	Gang Xu
		Production Engineering and Development Sect., Production Engineering Dept., Servo Systems Div.	Daiki Kobayashi
		Subsect. 2, Process Engineering Sect. 1, Production Engineering Dept., Servo Systems Div.,	Atsushi Endo

Technical Papers Published Outside the Company in General Technical Journals

January to December 2021

Title of Paper	Authors	Name of Journal	Issued in	Publisher
Feature: Products and Technology Development of Member Companies and the Results of 2021	SANYO DENKI CO., LTD	Denki (Electrical Appliances)	Jan. 2021	The Japan Electrical Manufacturers' Association (JEMA)
Expansion of the *SANUPS A11K-Li* Small-Capacity UPS Lineup	Takeo Murai, Shinichiro Yamagishi, Hideaki Yoda, Kazuya Yanagihara, Hirofumi Kimura, Shota Ozawa, Daisuke Tsuchiya, Yuki Takayama, Shota Takahashi	Monthly JETI	Jan. 2021	Nippon Syuppan Seisaku Center Inc.
Development of *SANMOTION C* Wireless Adapter 3A	Shigeki Sato, Tomonobu Tazaki Hiroto Endo, Naoto Miura, Masayuki Mizutani, Ryunosuke Murakami	Monthly JETI	Jun. 2021	Nippon Syuppan Seisaku Center Inc.
Technologies for Realizing New Dreams —Servo technologies that contribute to medical, welfare, and food fields—	Hideaki Kodama, Hidetoshi Hayashi	Monthly JETI	Aug. 2021	Nippon Syuppan Seisaku Center Inc.

Technical Papers Published Outside the Company

January to December 2021

Title of Paper	Authors	Name of Journal	Issued in	Publisher
Current Status and Future Prospects of Servo Systems	Daigo Kuraishi, Yasutaka Narusawa, Satoru Onodera	Journal of the Japan Society for Precision Engineering	Mar. 2021	The Japan Society for Precision Engineering
Study of Power Control Methods at the Power Receiving Points of Microgrids	Kazuto Yukita (Aichi Institute of Technology), Takuya Ota and Hiroaki Miyoshi (SANYO DENKI)	Conference paper collection	Jul. 2021	Technical Committee on Energy Engineering in Electronics and Communications(EE)

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