High Static Pressure Counter Rotating Fan *San Ace 40* 9CRH Type

Shuji Miyazawa Toshiyuki Nakamura Kenta Nishimaki Tetsuya Yamazaki

1. Introduction

In recent years, the density and heat generation of servers and power supply devices have been increasing. Particularly for 1U servers, there is a requirement for 40 × 40 mm fans with significantly higher static pressure performance. SANYO DENKI has previously developed and released a 40 × 40 × 56 mm counter rotating fan, however there is a growing number of cases in which this fan cannot provide the required cooling performance. For this reason, there is increased demand for high static pressure fans that are capable of cooling even high-density environments. Power consumption and sound pressure level (SPL) are also important issues.

In order to meet these requirements, SANYO DENKI has developed and released the 40 × 40 × 56 mm high static pressure counter rotating fan *San Ace 40* 9CRH type (hereinafter, "new model") which features a newly-designed impeller, frame, motor, and circuit.

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

2. Product Features

Figure 1 shows an external view of the new model.

Fig. 1: 40 × 56 mm *San Ace 40* 9CRH type

The features of the new model are:

(1) High static pressure
(2) Low power consumption
(3) Low SPL
(4) Optimal for 1U size units

3. Outline of the New Model

3.1 Dimensions

Figure 2 shows the dimensions of the new model.

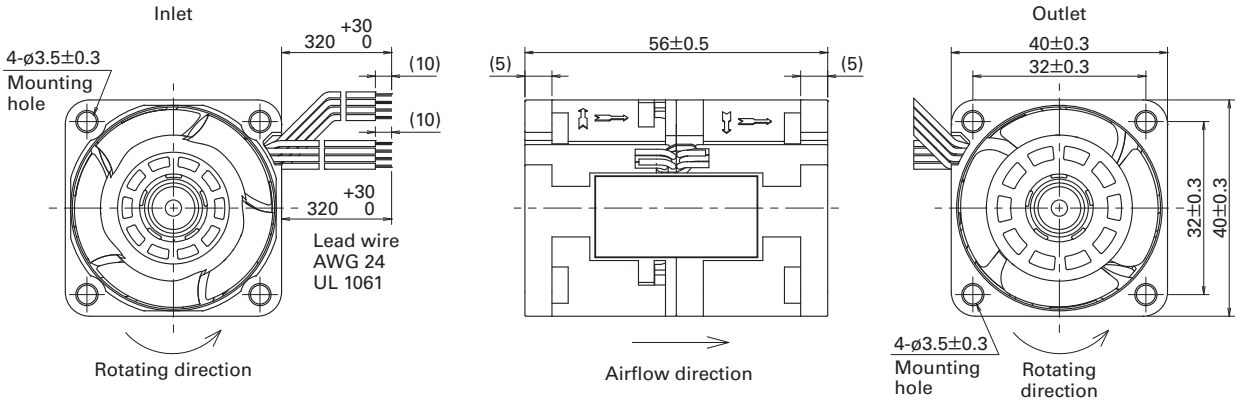


Fig. 2: Dimensions of the new model (unit: mm)

3.2 Characteristics

3.2.1 General specifications

Table 1 shows the general specifications for the new model.

The rated voltage is only 12 VDC, while the rated speed is 29,500 min^{-1} on the inlet side, and 25,500 min^{-1} on the outlet side.

Table 1: General specifications for the new model

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		SPL [dB (A)]	Operating temperature [°C]	Expected life [h]
						Inlet	Outlet	[m^3/min]	[CFM]	[Pa]	[inchH_2O]			
9CRH0412P5J001	12	10.8 to 12.6	100	2.52	30.24	29,500	25,500	0.93	32.9	1,700	6.83	70	-20 to +70	30,000 at 60°C
			20	0.06	0.72	3,000	2,600	0.08	2.8	17	0.07	20		

3.2.2 Airflow vs. static pressure characteristics

Figure 3 shows the airflow vs. static pressure characteristics for the new model.

3.2.3 PWM control function

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

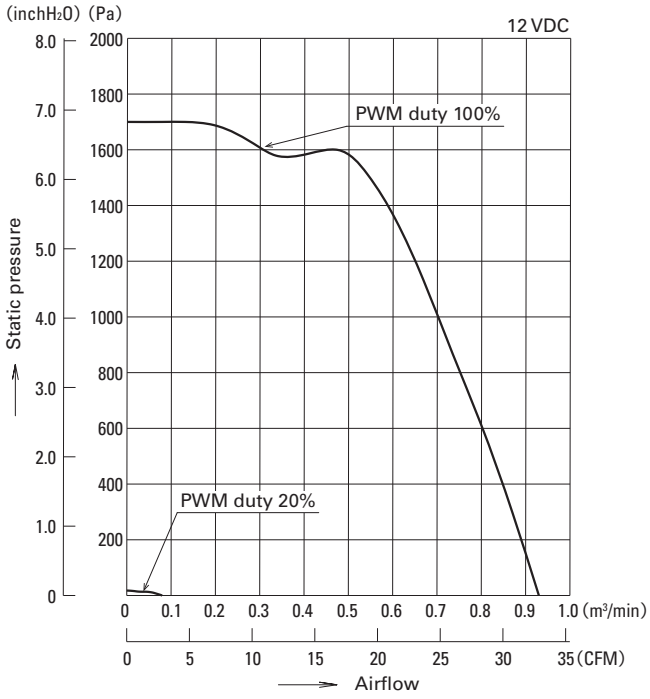


Fig. 3: Airflow vs. static pressure characteristics of the new model

4. Key Points of Development

The new model maintains a maximum airflow equivalent to that of the current model while offering significantly improved static pressure performance. High speed is essential to improving static pressure performance, so we redesigned the impeller, frame, motor, and circuit to achieve this.

Below, we explain the key points of development as well as the differences between the new model and the *San Ace 40* 9CRV type (hereinafter, "current model").

4.1 Impeller design

The impeller of the new model required sufficient strength to withstand a high speed of approximately 30,000 min^{-1}.

Based on the results of previous reliability evaluation tests, we used stress simulation technology and increased impeller blade thickness by approximately 1.4 times that of the current model to maintain sufficient strength.

Figure 4 shows the impellers of the inlet and outlet fans.

Figure 5 compares the blade thickness of the new and current models.

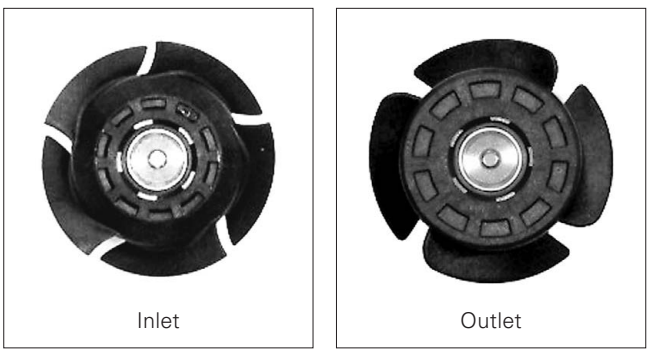


Fig. 4: Impellers of the inlet and outlet fans

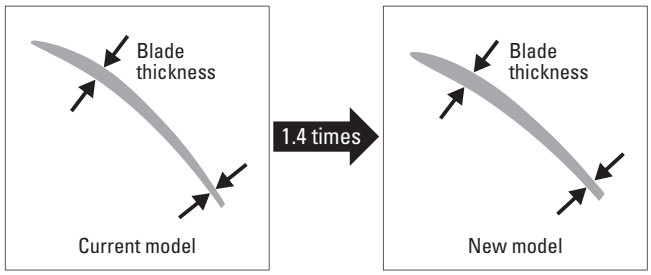


Fig. 5: Comparison of current and new model blade thicknesses

Increasing blade thickness has a significant impact on airflow vs. static pressure characteristics, power consumption, and SPL. However, by changing the inlet and outlet fans' impeller shape, mounting angle, and speed combinations, then repeatedly using 3D printing and performance evaluations for optimization, we successfully achieved the target performance.

4.2 Motor and circuit design

In order to increase fan speed, we redesigned the motor stator and changed the motor drive type from single-phase to 3-phase.

The 40 × 40 mm fan not only features a small PCB, but also adopts 3-phase motor, meaning it has a higher number of electronic components than the current model, and we were concerned that these could not all fit. As such, we were creative in the selection and arrangement of electronic components, which enabled us to build a new circuit without changing the size of the PCB from that of the current model.

Figure 6 shows the motor portion of the current model and new model.

Current model (single-phase) | New model (3-phase)

Fig. 6: Motors of the current model and new model

Due to its higher speed, the new model has a higher power consumption than the current model, however the change to a 3-phase motor has made it possible to reduce current waveform peak fluctuation to around one-third that of the current model.

Figure 7 is a comparison of current waveforms during steady operation.

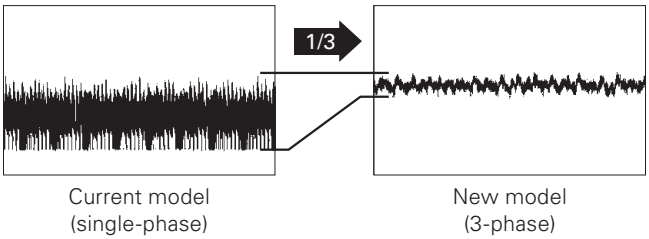


Fig. 7: Current waveforms during steady operation (comparison with current model)

5. Comparison with Current Model

5.1 Comparison of airflow vs. static pressure characteristics

The new model maintains the same maximum airflow as the current model but achieves 62% higher maximum static pressure.

Figure 8 provides an example of the airflow vs. static pressure characteristics of the current model and the new model.

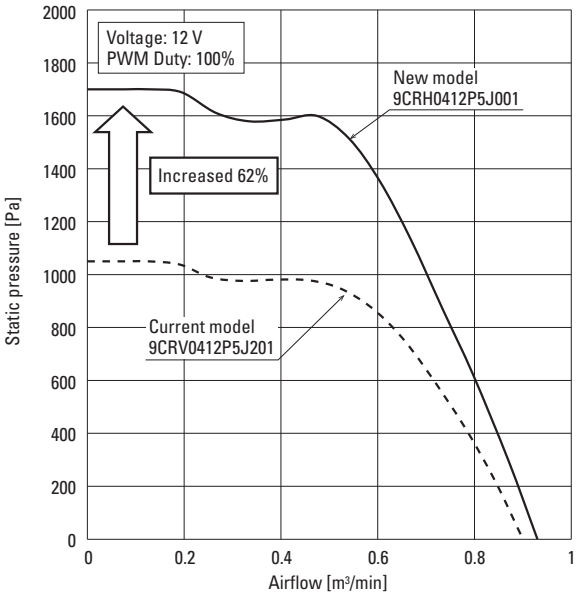


Fig. 8: Airflow vs. static pressure characteristics of current and new models

5.2 Power consumption comparison (when performance is equivalent to the current model)

Figure 9 provides a comparison of power consumption for the current and new models when their respective cooling performances are equivalent.

When the speed of the new model is lowered by PWM control and cooling performance at the assumed operating point is equivalent to that of the current model, the new model consumes 10% less power than the current model.

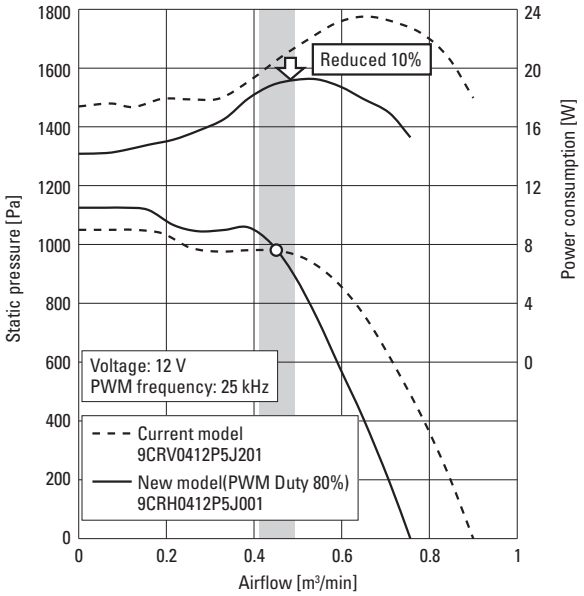


Fig. 9: Example of the airflow vs. static pressure characteristics (comparison with current model)

5.3 SPL comparison (when performance is equivalent to the current model)

Another focus when designing the new model was minimizing SPL and, as a result of innovative measures regarding inlet and outlet speed ratio and impeller shape, we succeeded in reducing SPL compared to the current model.

Figure 10 shows a comparison of SPL for the current and new model when cooling performances are equivalent.

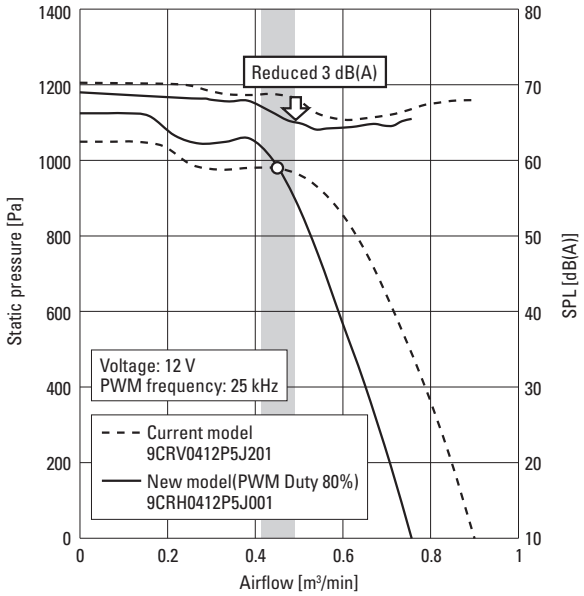


Fig. 10: Example of the airflow vs. static pressure characteristics (comparison with current model)

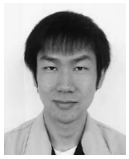
6. Conclusion

This article has introduced some of the features and performance of the 40 × 40 × 56 mm high static pressure counter rotating fan *San Ace 40* 9CRH type developed by SANYO DENKI.

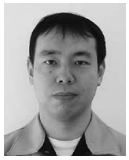
The new model has significantly higher static pressure than our current model while maintaining equivalent maximum airflow. Furthermore, when cooling performance is equivalent to that of the current model, the new model offers reduced power consumption and SPL.

We believe these features of the new model will significantly contribute to the cooling of equipment that is forecast to have even higher density and heat generation in the future.

SANYO DENKI is committed to engaging in product development that helps to fulfill new dreams and offering products that earn our customers' satisfaction.



Shuji Miyazawa
Joined SANYO DENKI in 2012.
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.



Toshiyuki Nakamura
Joined SANYO DENKI in 1999.
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Kenta Nishimaki
Joined SANYO DENKI in 2012.
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.

Tetsuya Yamazaki
Joined SANYO DENKI in 1997.
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.