Counter Rotating Fan “San Ace 92” 9CRA type

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1. Introduction

In recent years, the ICT market has been constantly expanding and data processing equipment such as servers, storage, and network devices are growing faster and larger in capacity. As such, the interior of such equipment is growing in density and generating more heat, increasing the demand for cooling fans with higher cooling performance.

Servers come in tower type, rack type, and blade type. Performance of storage and network devices are increasing while the capacity of power sources used in such equipment is also increasing. In line with such changes, the 92 mm sq. sized fans with high airflow and static pressure have come to be used to cool such equipment.

SANYO DENKI has produced and sold the 92 × 92 × 38 mm “San Ace 92” 9HV type (hereinafter “current model”) which offers high static pressure performance. Due to the abovementioned changes in equipment, an increasing number of customers had begun using two current model fans in series to increase cooling performance. Therefore, it was clear a need had emerged for a fan with higher cooling performance than previously available. To meet this demand, SANYO DENKI developed and produced its first ever 92 mm sq. Counter Rotating Fan, the “San Ace 92” 9CRA type (hereinafter “new model”), which achieves higher airflow and static pressure.

This paper 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: 92 × 92 × 76 mm
“San Ace 92” 9CRA type

The features of the new model are as follows:

(1) High airflow and high static pressure
(2) Low power consumption
(3) Low vibration

3. Outline of the New Model

3.1 Dimensions

Figure 2 shows the dimensions of the new model.

3.2 Characteristics

3.2.1 General characteristics

Table 1 shows the general characteristics for the new model.
The main characteristics are as shown below.

- Rated voltage: 12/48 VDC
- Rated input: 108.0 W (12 VDC) / 105.6 W (48 VDC)
- Rated speed:
  Inlet side 13,300 min^{-1} / Outlet side 12,200 min^{-1}
  (Common to both voltages)

- Maximum airflow: 5.8 m^3/min (Common to both voltages)
- Maximum static pressure: 1,650 Pa (Common to both voltages)
- Sound pressure level (SPL): 81 dB(A) (Common to both voltages)

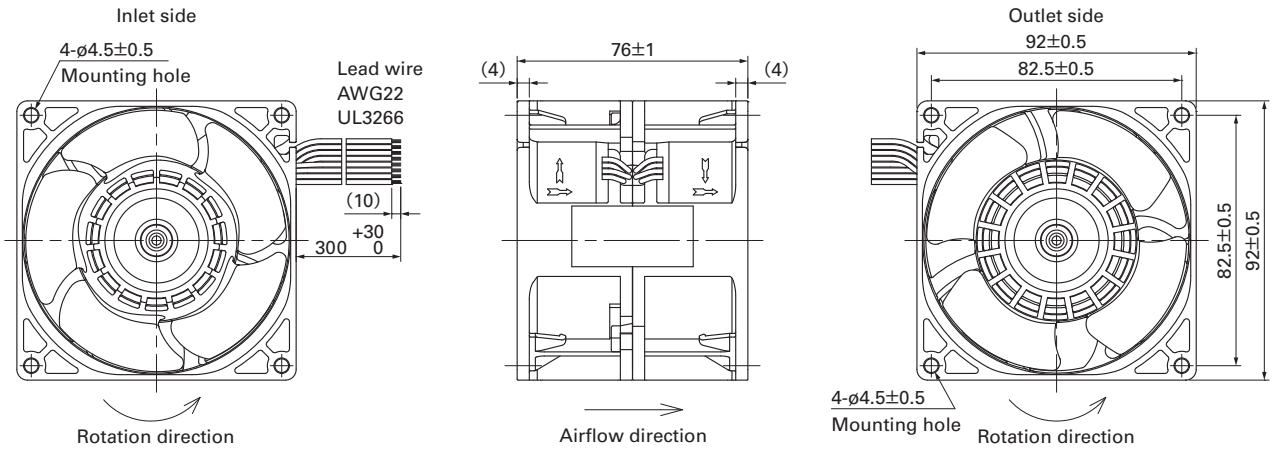


Fig. 2: Dimensions of the new model (unit: mm)

Table 1: General characteristics 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}] Inlet side	Rated speed [min^{-1}] Outlet side	Max. airflow [m^3/min]	Max. airflow [CFM]	Max. static pressure [Pa]	Max. static pressure [inchH_2O]	SPL [dB(A)]	Operating temperature [°C]	Expected life [h]
9CRA0912P0G001	12	10.2 to 13.2	100	9.0	108.0	13,300	12,200	5.8	205	1,650	6.63	81	-20 to +70	40,000 to 60°C (70,000/40°C)
			20	0.42	5.04	3,500	3,200	1.48	52.3	140	0.56	47		
9CRA0948P0G601	48	36 to 60	100	2.2	105.6	13,300	12,200	5.8	205	1,650	6.63	81		
			20	0.15	7.20	3,500	3,200	1.48	52.3	140	0.56	47		

Note 1: Input PWM frequency: 25 kHz
Note 2: Speed is 0 min^{-1} at 0% PWM duty cycle

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 the fan speed.

3.3 Expected life

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

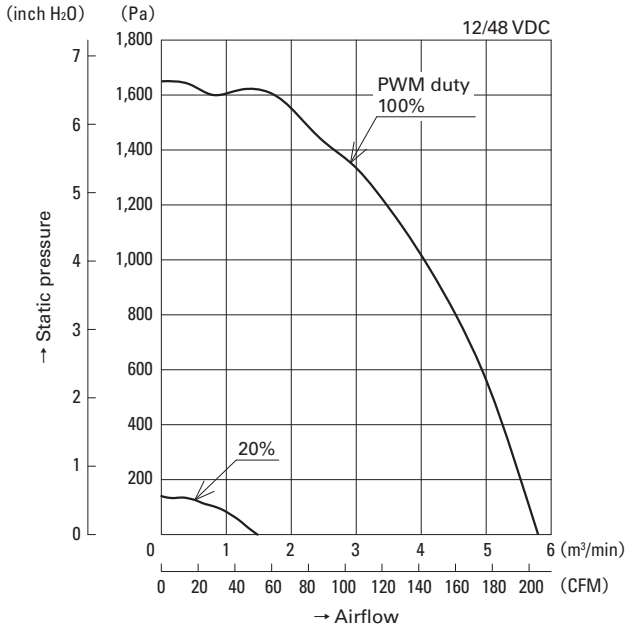


Fig. 3: Airflow vs. static pressure characteristics of new model

4. Key Points of Development

The impellers, frame, and circuit of the new model were newly designed, resulting in better performance than the two current models in series.

The key points of development are explained below.

4.1 Impeller and frame design

The Counter Rotating Fan has an inlet impeller and an outlet impeller, and the combination of their shapes, mounting angles, and rotational speeds significantly affect airflow vs. static pressure characteristics. Furthermore, the shape of the frame spokes also impacts aerodynamics, power consumption, and sound pressure level. The new model was designed using fluid analysis and 3D modeling to find the optimal combination of impeller shape, spoke shape, and mounting angle.

Surface area of the impellers was increased and the shape designed to optimize pressure distribution on the impellers' surface to improve airflow and static pressure without raising fan speed.

In order to increase frame strength and reduce fan vibration, the number of spokes was increased and the shape was designed to allow air to flow smoothly without impeding the air supplied by the inlet fan.

Figure 4 shows the pressure distribution on the inlet/outlet fan surfaces and spoke surfaces using fluid analysis.

In the example showing the initial stage of development, there were areas of negative air pressure on the surfaces of the impeller blades, however for the new model, the change in pressure distribution is gradual across the surfaces of all of the blades and spokes. As a result, it was possible to reduce fluid separation which causes pressure loss, leading to an increase in high static pressure.

In this way, the newly shaped impeller and spokes have made it possible to achieve higher airflow and higher static pressure.

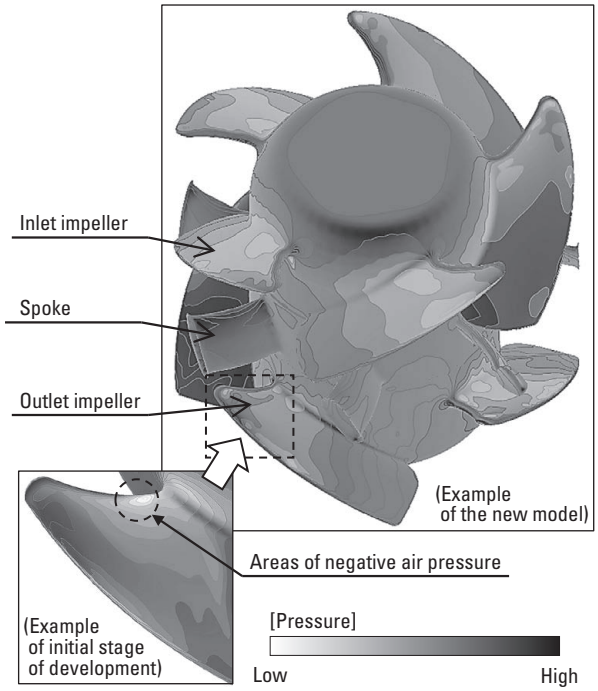


Fig. 4: Example of pressure distribution on the blade and spoke surfaces using fluid analysis

4.2 Circuit design

In regards to circuit design, the ideal motor drive method to support high airflow and high static pressure was adopted and the most suitable circuit configuration and drive control program to suit the drive mode were selected.

This is explained below using the 12 VDC rated voltage product as an example.

The new model (9CRA0912P0G001) has a 3-phase drive motor, while the current model (9HV0912P1G001) has a single-phase drive motor. Compared with two current models operating in series, the new model is able to suppress the maximum current waveform by 24% thanks to its 3-phase motor. Moreover, peak fluctuation of the current waveform has shrunk by 60% against the conventional product.

Figure 5 is a comparison of current waveforms during steady operation of the new model and two current model units operating in series.

The result is an increase in airflow and static pressure with far fewer mounted components.

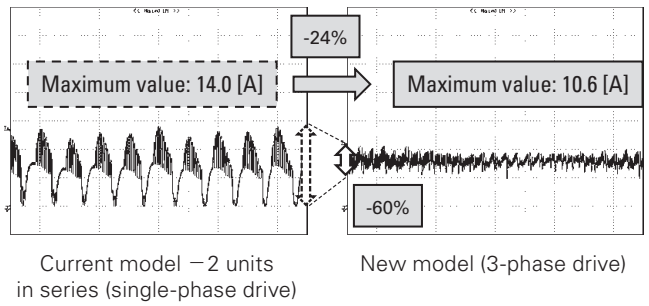


Fig. 5: Comparison of current waveforms during steady operation

5. Comparison with Current Models

5.1 Comparison of airflow vs. static pressure

The new model has a maximum airflow 1.14 times that of two current model units operating in series. At its highest, the new model achieves 1.2 times the airflow and 1.5 times the static pressure of the current model when operating within the expected operating range and with the same system impedance.

Figure 6 provides an example of the airflow vs. static pressure characteristics of the new model and two current model units in series.

5.2 Power consumption comparison (when performance is equivalent to two current model units in series)

Figure 7 uses the 12 VDC rated voltage product to compare the power consumption of the new model with two current model units operating in series when delivering the same cooling performance.

If the speed of the new model (9CRA0912P0G001) is lowered using PWM control to mimic the cooling performance of two current model (9HV0912P1G001) units in series while in the expected operating range, the new model will use more than 10% less power.

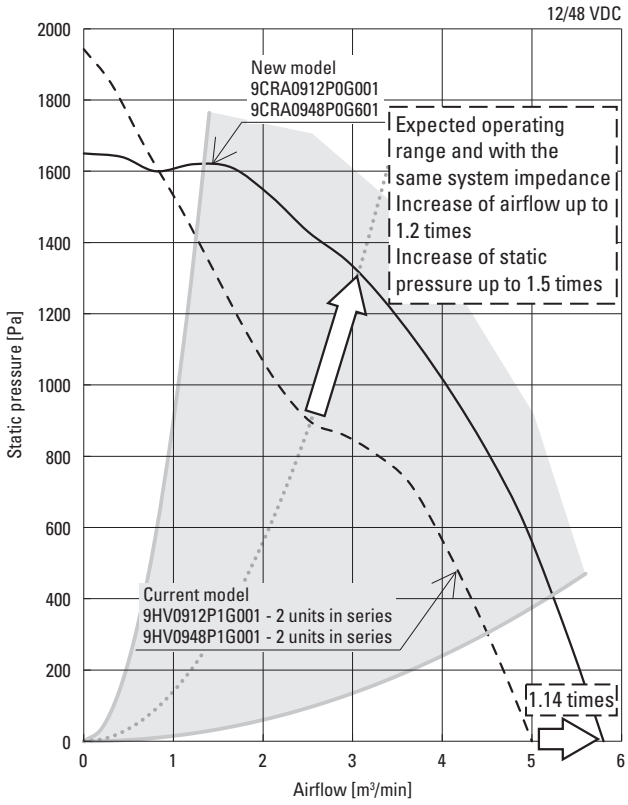


Fig. 6: Example of the airflow vs. static pressure characteristics for the new model and two current model units in series

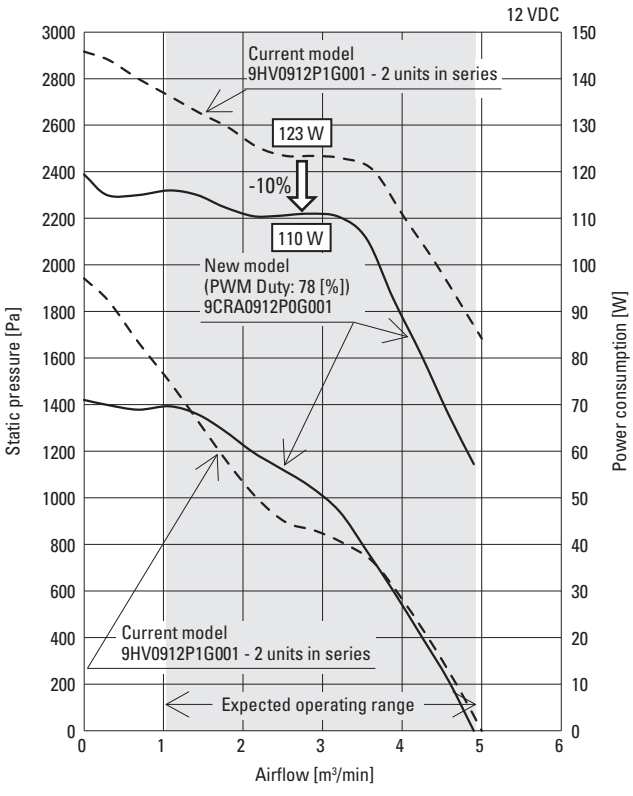


Fig. 7: Example of the airflow vs. static pressure characteristics (comparison with two current model units operating in series)

5.3 Comparison of vibration characteristics

Figure 8 uses the 12 VDC rated voltage product as an example to show a comparison of speed vs. vibration acceleration characteristics between the new model and the current model.

The new model (9CRA0912P0G001) has less vibration than the current model (9HV0912P1G001) due to increased frame strength and improvements made to the motor and circuit.

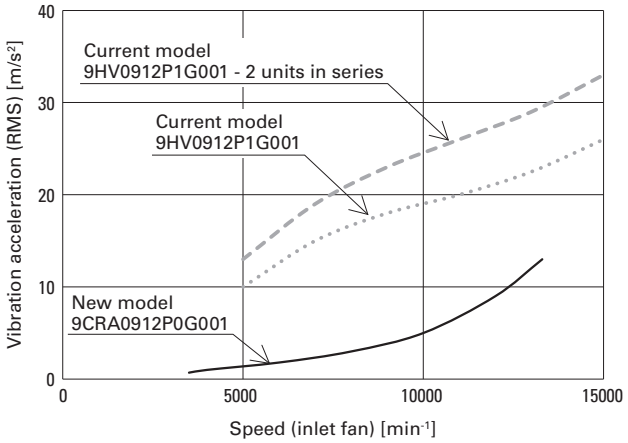


Fig. 8: Example of the speed vs. vibration acceleration characteristics (comparison with the current model)

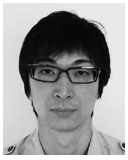
6. Conclusion

This paper has introduced the features and performance of the 92 × 92 × 76 mm Counter Rotating Fan “San Ace 92” 9CRA type developed by SANYO DENKI.

Compared with the conventional model, the new model offers higher airflow, higher static pressure, lower power consumption, and reduced vibration.

We believe these features of the new model will contribute to the cooling of high-heat generating, high-density equipment predicted to continue advancing in the future.

SANYO DENKI wishes to continue developing products to meet market needs and contribute to the creation of our customers’ new value, and help customers achieve happiness and make their dreams come true.



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