High Airflow, Large Centrifugal Fans "San Ace C225" and "San Ace C221"

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1. Introduction

In recent years, it has become necessary to improve the cooling performance inside equipment due to an increase in equipment internal heat generation in line with a transition to the high performance and high density of servers and communication equipment. As such, there are increasing demands for the fans used for cooling purposes to offer higher airflow and higher static pressure.

Sanyo Denki has commercialized various axial flow fans and blowers in order to meet these demands. However, due to the applications sought for in fans, it became necessary to offer the centrifugal fan as a new option differing to the axial flow fan and blower.

Sanyo Denki had commercialized centrifugal fans up to ϕ175 in size however, in order to meet demands for even higher airflow and static pressure, we developed and commercialized two large centrifugal fan models, one ϕ225 mm x 99 mm thick and the other ϕ221 mm x 71 mm thick.

This report introduces the features and performances of these high airflow, large centrifugal fans, the "San Ace C225" 9TS type and the "San Ace C221" 9TP type (hereinafter referred to as "new models").

2. Features of the New Models

Figures 1 and 2 show the "San Ace C225" and the "San Ace C221", respectively.

The new models have the following features:

(1) High airflow and high static pressure
(2) Low power consumption, low sound pressure level (SPL)
(3) PWM speed control function
(4) Support for wide voltage range

The blade, frame, and motor were newly developed for the new models in order to achieve high airflow and high static pressure.

Fig. 1: "San Ace C225" 9TS type

Fig. 2: "San Ace C221" 9TP type

3. Outline of the New Models

3.1 Dimensions

Figures 3 and 4 show the dimensions of the new models.

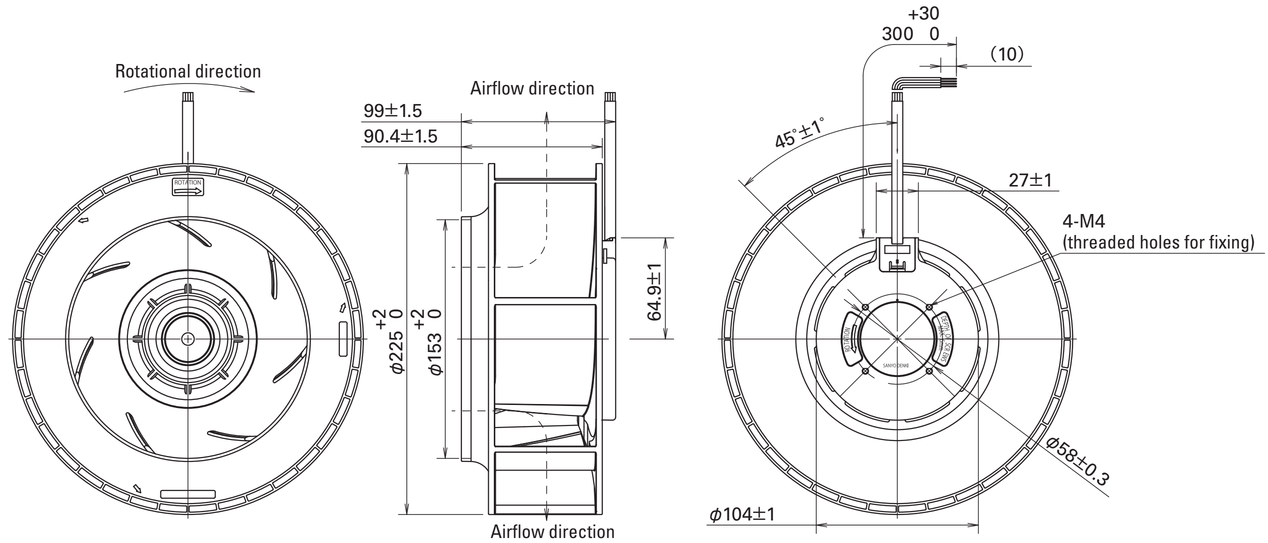

Fig. 3: “San Ace C225” 9TS type dimensions (unit: mm)

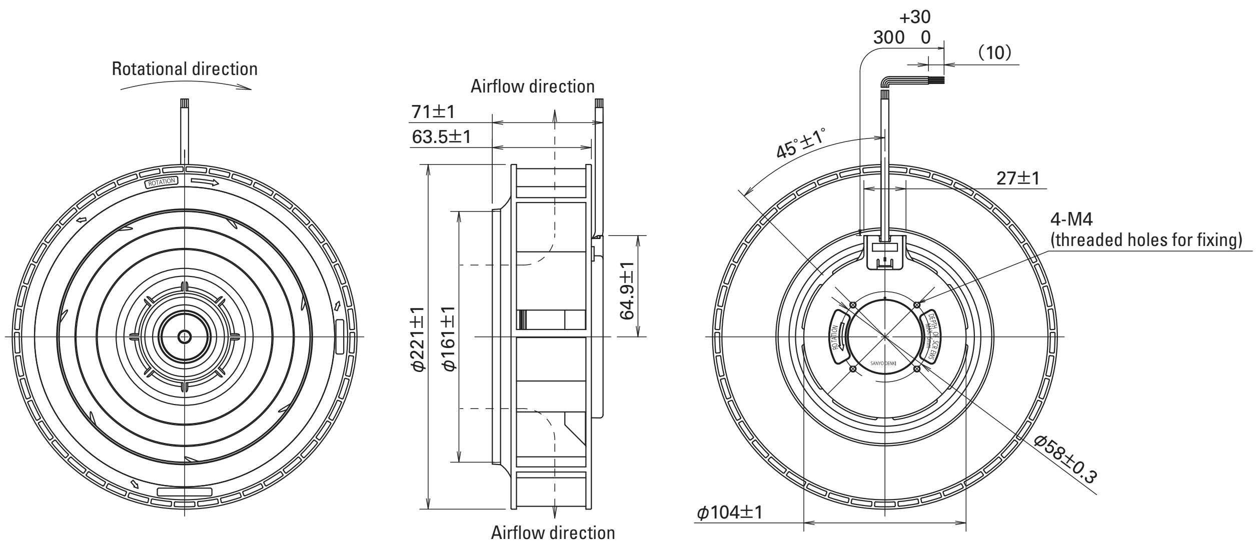

Fig. 4: “San Ace C221” 9TP type dimensions (unit: mm)

3.2 Inlet nozzle

The inlet nozzle is mounted on the fan inlet port in order to smooth out the flow of incoming air and is attached to the equipment on the side where the fan will be integrated. Performance of the centrifugal fan is greatly affected by the shape of this inlet nozzle. Sanyo Denki has special-purpose inlet nozzles for each model.

Figure 5 shows a mounting example of the new model and inlet nozzle, while Figures 6 and 7 show examples of mounting dimensions. The new models are mounted using four M4 screws, and the inlet nozzle is mounted using four M4 screws and four nuts.

Moreover, by providing a shape on the equipment side the same as the inlet nozzle, substitution is possible.

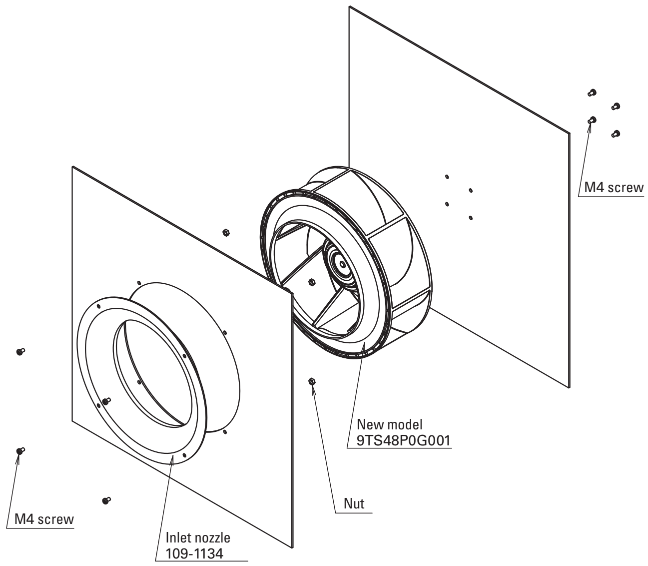

Fig. 5: An example of mounting the inlet nozzle on the "San Ace C225" 9TS type

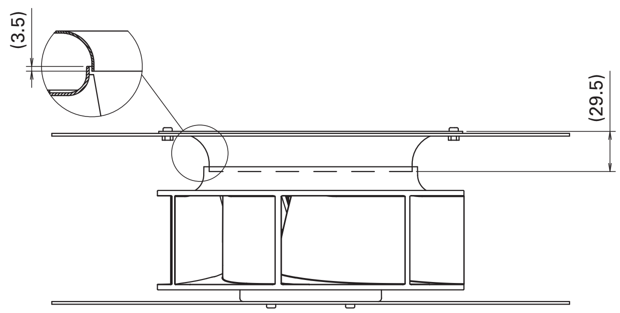

Fig. 6: Example of the "San Ace C225" 9TS type and inlet nozzle mounting dimensions (unit: mm)

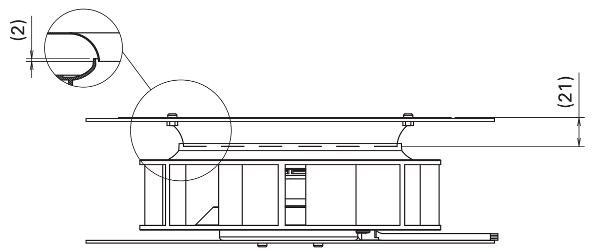

Fig. 7: Example of the "San Ace C221" 9TP type and inlet nozzle mounting dimensions (unit: mm)

3.3 Characteristics

3.3.1 General characteristics

Tables 1 and 2 show the general characteristics for the new models.

Centrifugal fan characteristics give values obtained with a Sanyo Denki inlet nozzle attached.

3.3.2 Airflow vs. static pressure characteristics

Figures 8 and 9 show the airflow versus static pressure characteristics for the new models.

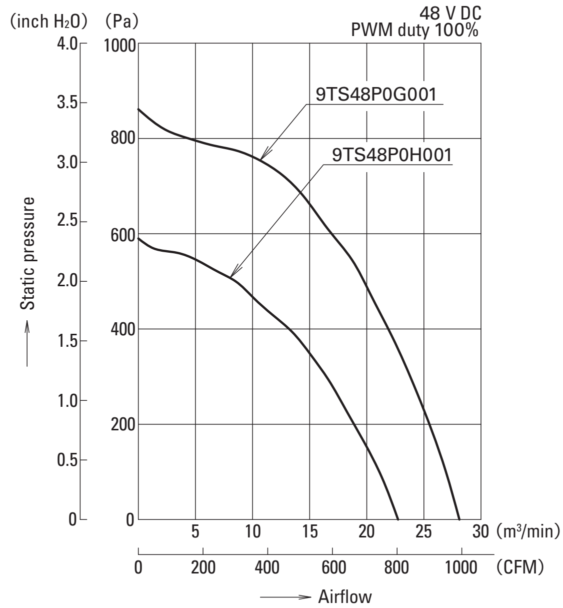

Fig. 8: Airflow vs. static pressure characteristic of the "San Ace C225" 9TS type

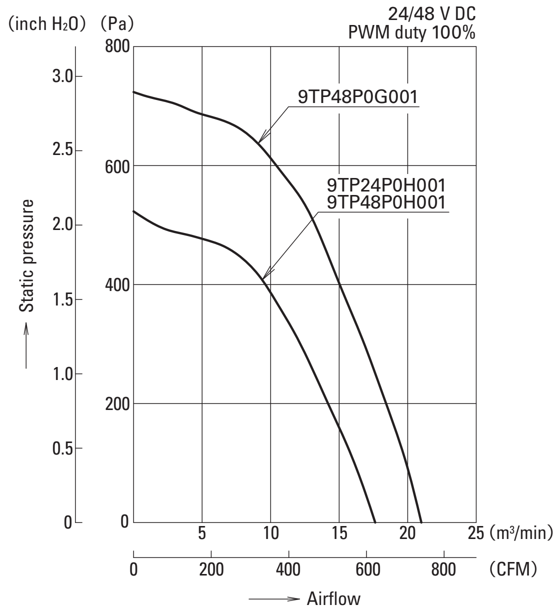

Fig. 9: Airflow vs. static pressure characteristic of the "San Ace C221" 9TP type

3.3.3 PWM control function

All new models have a PWM control feature which enables speed control.

3.3.4 Support for a wide voltage range

In order to support the fluctuation of voltage in equipment, operating voltage covers a wide range, specifically 36 to 72 V with a rated voltage of 48 V DC and 16 to 36 V with a rated voltage of 24 V DC.

3.4 Expected life

The expected life (survival rate 90%) of the new models at an ambient temperature of 60°C is 40,000 hours.

Table 1: “San Ace C225” 9TS type general characteristics

Model No.	Rated voltage [V]	Operating voltage [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]
							[m^3/min]	[CFM]	[Pa]	[inchH_2O]			
9TS48P0G001	48	36 to 72	100	3.65	175.2	3550	28.1	992	861	3.46	74.5	-20 to +60	40,000/60°C
			15	0.24	11.5	1000	7.85	277	68.5	0.28	52.0		
9TS48P0H001	48	36 to 72	100	2.08	99.8	2900	22.7	801	590	2.37	70.5	-20 to +70	
			15	0.24	11.5	1000	7.85	277	68.5	0.28	52.0		

Note 1: Input PWM frequency: 25 kHz
Note 2: Speed is 0 min^{-1} at 0% PWM duty cycle
Note 3: With Sanyo Denki’s inlet nozzle (model No.: 109-1134) attached

Table 2: “San Ace C221” 9TP type general characteristics

Model No.	Rated voltage [V]	Operating voltage [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]
							[m^3/min]	[CFM]	[Pa]	[inchH_2O]			
9TP48P0G001	48	36 to 72	100	2.75	132	3650	21	742	760	3.05	74	-20 to +60	40,000/60°C
			15	0.2	9.6	1000	5.75	203	57.4	0.23	53		
9TP48P0H001	48	36 to 72	100	1.6	76.8	3050	17.6	622	530	2.13	71	-20 to +70	
			15	0.2	9.6	1000	5.75	203	57.4	0.23	53		
9TP24P0H001	24	16 to 36	100	3.2	76.8	3050	17.6	622	530	2.13	71	-20 to +70	
			15	0.4	9.6	1000	5.75	203	57.4	0.23	53		

Note 1: Input PWM frequency: 25 kHz
Note 2: Speed is 0 min^{-1} at 0% PWM duty cycle
Note 3: With Sanyo Denki’s inlet nozzle (model No.: 109-1135) attached

4. Development Point

4.1 Impeller design

The new models are larger than the maximum-size conventional centrifugal fan (ϕ175), meaning that greater centrifugal force would be applied to the impeller, hence we adopted an integrated design in order to improve strength.

By optimizing impeller shape, angle and number, we achieved low SPL and low power consumption at the same time as high cooling performance.

In order to minimize the heat of the motor, we adopted a structure which allowed air to easily pass through the fan.

4.2 Motor design

In order to achieve low power consumption, we not only optimized impeller shape, but also improved the efficiency of the motor.

First, we revised the stator shape and increased the coil space factor. By enlarging the stator, motor efficiency can easily be improved however this also increases the size of the rotor compared with the impeller, therefore inhibiting the airflow and reducing the airflow vs. static pressure characteristic. Consequently, we designed a stator size which would improve motor efficiency to the extent possible without reducing the airflow vs. static pressure characteristic.

We also revised the magnet material and magnetization method. Regarding material, we selected a magnet with higher performance than the conventional product and which was optimal for the specifications. We also optimized the magnetization method and successfully improved motor efficiency.

In regards to the drive circuit also, we succeeded in reducing power by revising the structure and electronic components, thus reducing circuit loss.

5. Comparison with the axial flow fan

This section compares the characteristics of the new model, ϕ221 centrifugal fan 9TP48P0G001, and axial flow fan, 9GV2048P0G201, which has equal volume.

Figure 10 shows the comparison of airflow versus static pressure characteristics when the axial flow fan is running with speed to match the cooling performance of the new model.

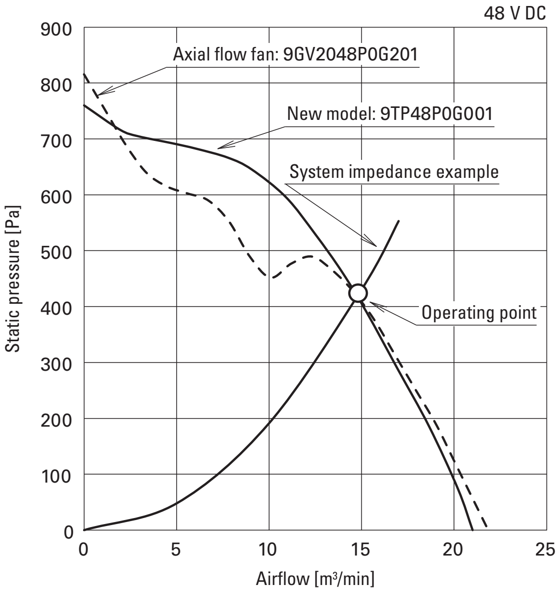

Fig. 10: Comparative example of the airflow vs. static pressure characteristic

5.1 Comparison of power consumption and SPL

Figure 11 shows the power consumption and sound pressure level of each fan at the operating point of 15 m^3/min 420 Pa proximity for the presumed system impedance.

Compared with when the axial flow fan is used, the new model is capable of reducing power consumption by 6% and SPL by 3 dB (A).

5.2 Comparison of airflow

It is anticipated that a new model will achieve significant reduction in power consumption and SPL compared with an axial flow fan when exhibiting equal cooling performance.

However, the flow of air is different for a centrifugal fan and an axial flow fan, and therefore you need to determine which is appropriate depending on the restrictions on the flow channel for the included equipment and thoughts on the flow channel design.

Figure 12 shows an image of the airflow for both the centrifugal fan and axial flow fan.

The axial flow fan discharges air in a coaxial direction. The centrifugal fan discharges air in a radial direction against the intake direction.

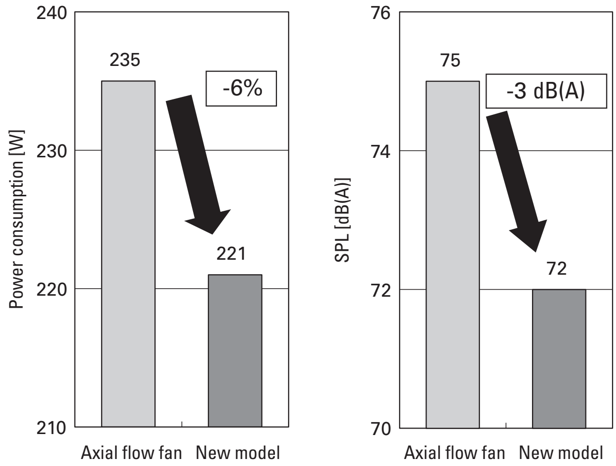

Fig. 11: Comparison of power consumption and SPL

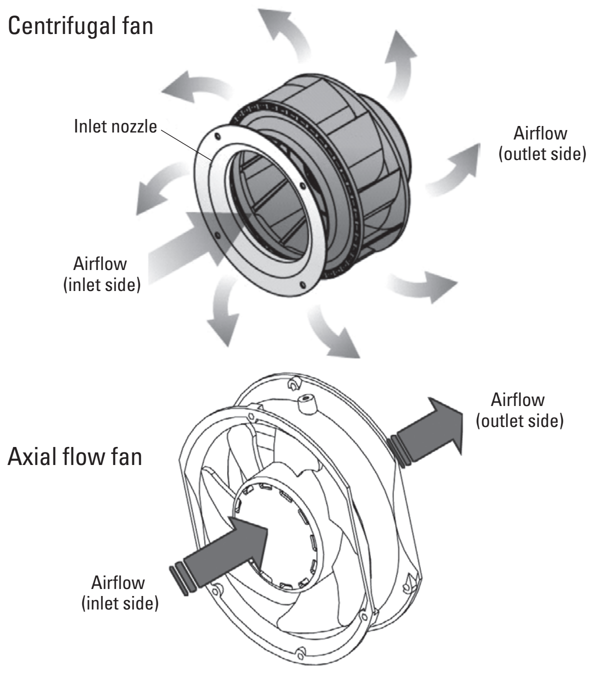

Fig. 12: Airflow of a centrifugal fan and an axial flow fan

5.3 An example of centrifugal fan usage

Figure 13 is an example of an arrangement when a centrifugal fan is incorporated on equipment.

External air is taken in from the bottom side of the equipment and the heat generated from the heat source is discharged from the top side.

For this equipment, it would be necessary to secure sufficient space in the ceiling of the equipment if an axial flow fan was used, however if a centrifugal fan was used, it would be possible to efficiently cool the equipment even with a small space.

In addition, not only is this fan capable of conventional cooling, but also transferring air, such as in large FFU (fan filter units) for clean rooms used on semiconductor and pharmaceutical manufacturing lines.

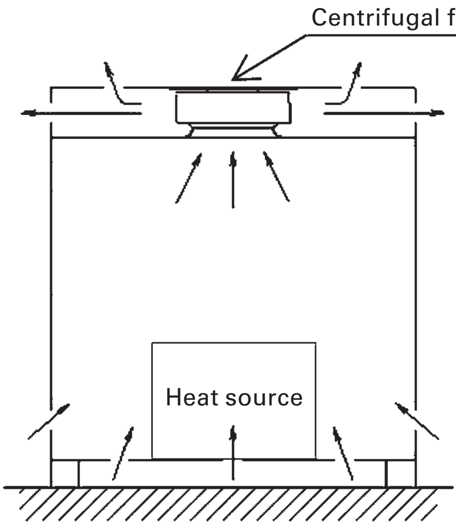

Fig. 13: An example of centrifugal fan usage

6. Conclusion

This report introduced some of the features and performances of Sanyo Denki's new products, the high airflow, large centrifugal fans, "San Ace C225" 9TS type and "San Ace C221" 9TP type.

By optimizing the impeller shape and motor drive circuit, we have achieved high airflow and high static pressure at the same time as low power consumption and low SPL. Both models exhibit the highest performance in the industry* for centrifugal fans of the same size.

It is predicted that the high heat generation and high density of equipment will continue to increase in the future and, in consideration of the environment, the demands for low SPL and low power consumption will grow.

These new models have characteristics beneficial towards such issues and we believe they will help to provide a solution.

*) "San Ace C225"
Current as of Jan. 23, 2015. As a centrifugal fan of the same size. Comparison of SPL and power when the airflow and static pressure are equal. Results from Sanyo Denki inspection.

"San Ace C221"
Current as of Feb. 9, 2015. As a centrifugal fan of the same size. Comparison of SPL and power when the airflow and static pressure are equal. Results from Sanyo Denki inspection.

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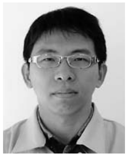

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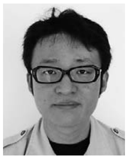

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