# 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

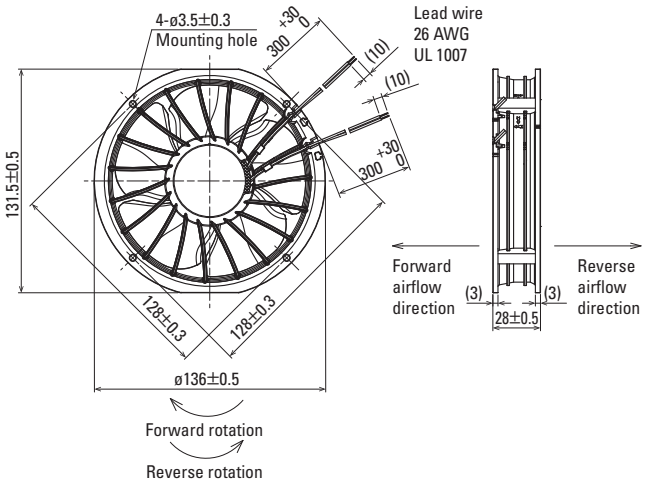


Fig. 2 Dimensions of the *San Ace 136RF* 9RFA type (Unit: mm)

### 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.

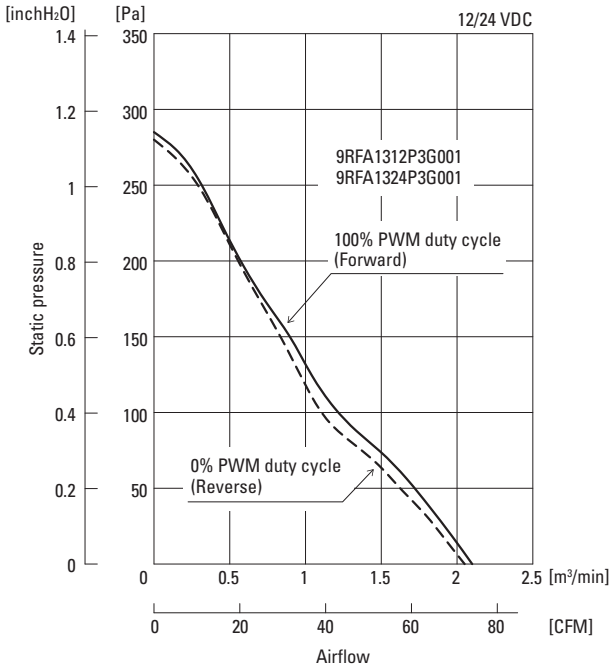


Fig. 3 Airflow vs. static pressure characteristics of new G-speed models

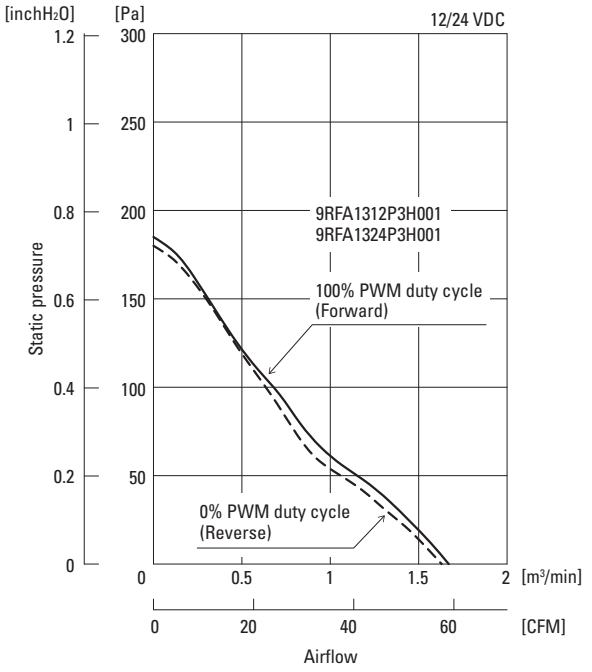


Fig. 4 Airflow vs. static pressure characteristics of new H-speed models

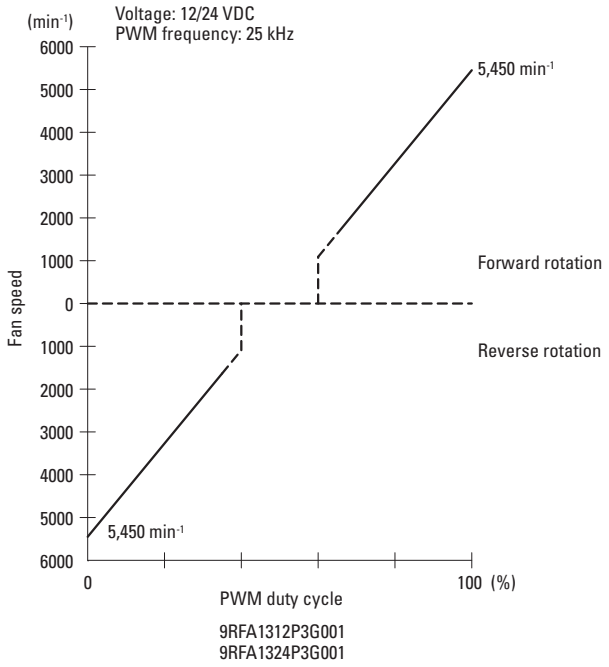


Fig. 5 PWM characteristics of new G-speed models

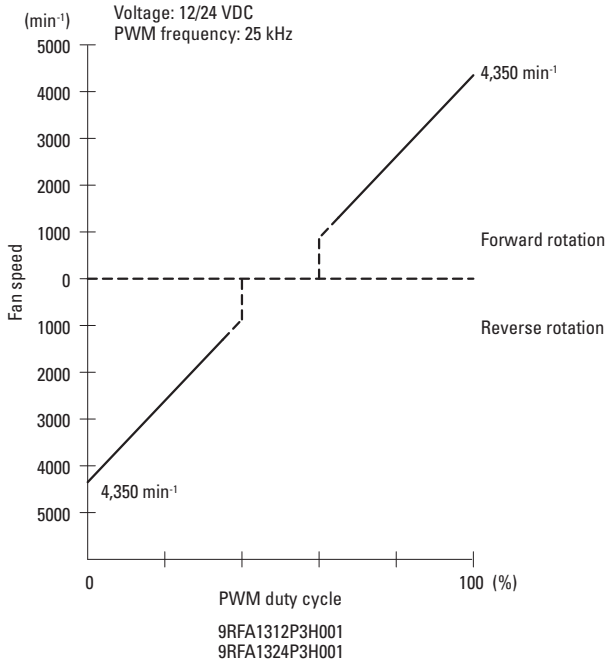


Fig. 6 PWM characteristics of new H-speed models

## 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.

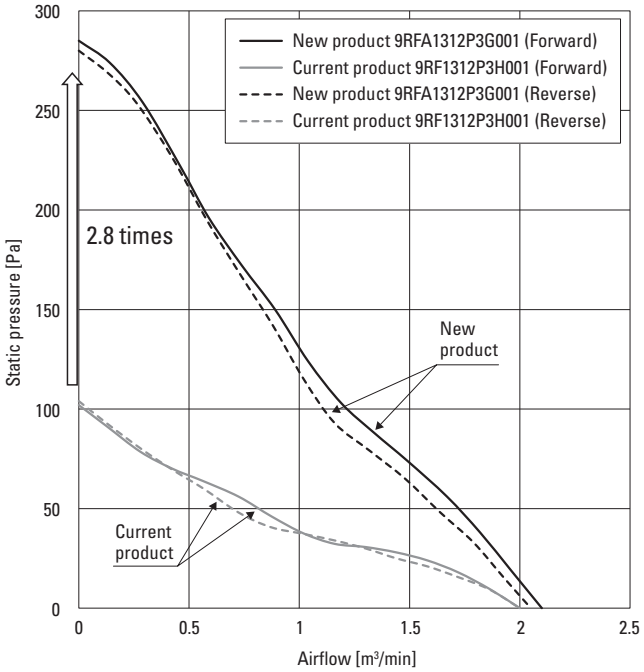


Fig. 9 Comparison of the airflow vs. static pressure characteristics between the new and current products

### 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.

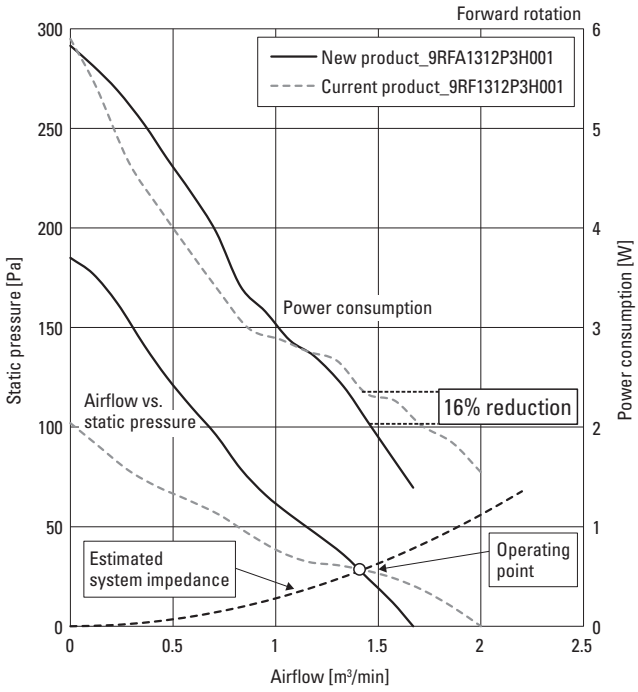


Fig. 10 Power consumption comparison with the current product

## 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.

Author

**Seiji Takeuchi**
Design Dept., Cooling Systems Div.
Works on the development and design of cooling fans.

**Osamu Nishikawa**
Design Dept., Cooling Systems Div.
Works on the development and design of cooling fans.

**Yoshihisa Yamazaki**
Design Dept., Cooling Systems Div.
Works on the development and design of cooling fans.

**Tomohide Nonomura**
Design Dept., Cooling Systems Div.
Works on the development and design of cooling fans.

**Toranosuke Hirata**
Design Dept., Cooling Systems Div.
Works on the development and design of cooling fans.

**Hiromitsu Kuribayashi**
Design Dept., Cooling Systems Div.
Works on the development and design of cooling fans.