

# G Proof Fans

## *San Ace 120GP* and *San Ace 172GP*

Naoya Inada      Jiro Watanabe      Atsushi Yanagisawa

Masato Kakeyama      Masaki Kodama      Tetsuya Yamazaki

### 1. Introduction

In recent years, there has been a growing demand for fans able to be used in environments subjected to centrifugal acceleration, commonly known as G-force. One example is the fan used for cooling the interior of medical CT scanners.

Medical CT scanners have a high-speed rotating gantry that scans the human body. For this reason, the fan that cools the gantry is subjected to high levels of G-force. It is believed that medical CT scanners will offer even higher performance and higher reliability, leading to greater demand for fans that can be used in environments with higher levels of G-force.

To meet such demands in the medical industry market, SANYO DENKI developed and produced the *San Ace 120GP* and *San Ace 172GP* 9GP type G Proof Fans (hereinafter, “new product”).

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

### 2. Product Features

The features of the new product are:

- (1) Ability to withstand G-forces of 75 G
- (2) Low power consumption
- (3) PWM speed control function

Figures 1 and 2 show external views of the new product.

### 3. Outline of the New Product

#### 3.1 Dimensions

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

The fan’s external dimensions and mounting hole dimensions are compatible with our existing product.



Fig. 1: 120 × 120 × 38 mm G Proof Fan  
*San Ace 120GP* 9GP type



Fig. 2:  $\phi 172 \times 150 \times 51$  mm G Proof Fan  
*San Ace 172GP* 9GP type

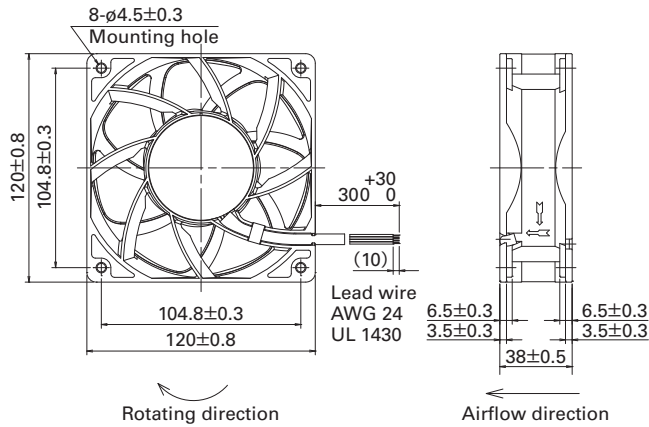


Fig. 3: Dimensions of the 120 × 120 × 38 mm *San Ace 120GP* (unit: mm)

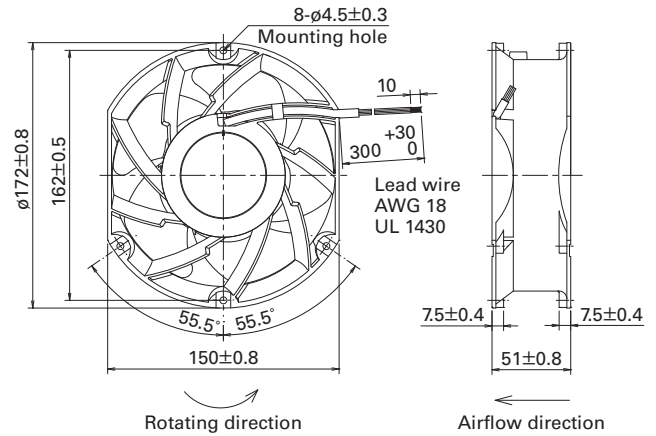


Fig. 4: Dimensions of the ø172 × 150 × 51 mm *San Ace 172GP* (unit: mm)

## 3.2 Specifications

### 3.2.1 General specifications

Tables 1 and 2 show the general specifications for the new product.

Table 1: General specifications of the 120 × 120 × 38 mm *San Ace 120GP*

Model No.	Rated voltage [V]	Operating voltage range [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min <sup>-1</sup> ]	Max. airflow		Max. static pressure		SPL [dB(A)]	Operating temperature range [°C]	Expected life [h]	Level of G-force tolerance [G]			
							[m <sup>3</sup> /min]	[CFM]	[Pa]	[inchH <sub>2</sub> O]							
9GP1224P1G001	24	15 to 30	100	1.60	38.40	6,550	7.00	247.1	370	1.48	62	-20 to +70	40,000 at 60°C	75			
			20	0.12	2.88	2,000	2.13	75.2	34.4	0.13	36						
9GP1248P1G001	48	36 to 60	100	0.80	38.40	6,550	7.00	247.1	370	1.48	62				-20 to +70	40,000 at 60°C	75
			20	0.08	3.84	2,000	2.13	75.2	34.4	0.13	36						

Note: Speed is 0 min<sup>-1</sup> at 0% PWM duty cycle

\* Input PWM frequency: 25 kHz

Table 2: General specifications of the ø172 × 150 × 51 mm *San Ace 172GP*

Model No.	Rated voltage [V]	Operating voltage [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min <sup>-1</sup> ]	Max. airflow		Max. static pressure		SPL [dB(A)]	Operating temperature range [°C]	Expected life [h]	Level of G-force tolerance [G]			
							[m <sup>3</sup> /min]	[CFM]	[Pa]	[inchH <sub>2</sub> O]							
9GP5724P5H001	24	16 to 30	100	5.0	120	8,000	12.3	434	1,000	4.02	77	-20 to +70	40,000 at 60°C	75			
			20	0.5	12.0	3,000	4.6	162	175	0.70	51						
9GP5748P5G001	48	36 to 72	100	5.0	240	10,500	16.1	568	1,600	6.43	83				-20 to +70	40,000 at 60°C	75
			20	0.41	19.7	3,700	5.6	198	250	1.01	57						

Note: Speed is 0 min<sup>-1</sup> at 0% PWM duty cycle

\* Input PWM frequency: 25 kHz

### 3.2.2 Highly resistant to G-forces

The new product is able to withstand G-forces of up to 75 G (at normal temperature, normal humidity, continuous operation).

### 3.2.3 Airflow vs. static pressure characteristics

Figures 5 and 6 show the airflow vs. static pressure characteristics for the new product.

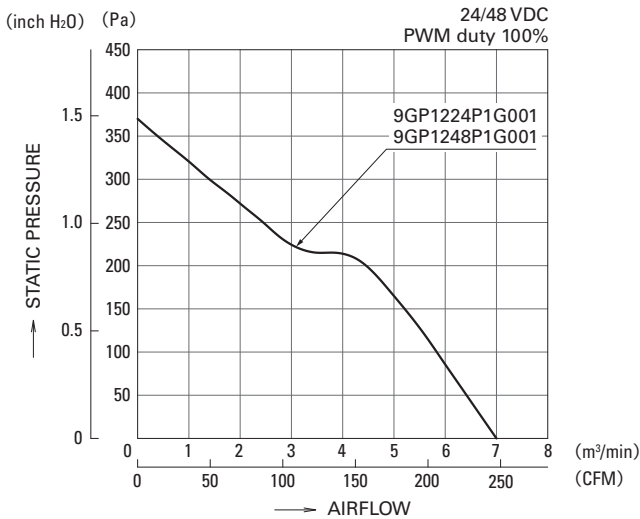


Fig. 5: Airflow vs. static pressure characteristics of the 120 × 120 × 38 mm *San Ace 120GP*

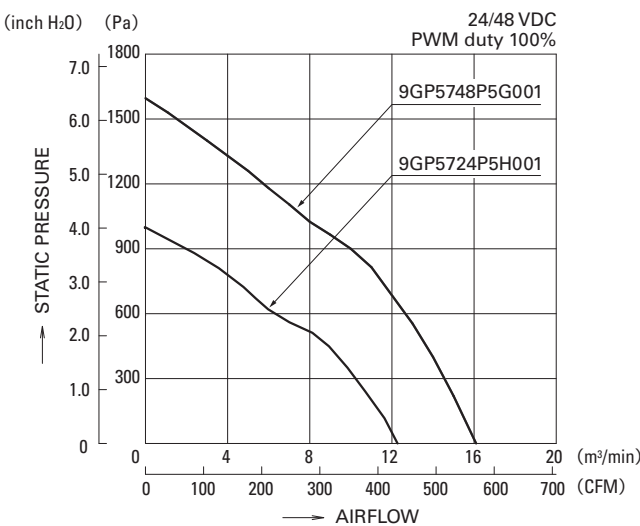


Fig. 6: Example of the ø172 × 150 × 51 mm *San Ace 172GP* airflow vs. static pressure characteristics

### 3.2.4 PWM control function

The new product is equipped with the PWM control function that enables external control of fan speed, contributing to lower sound pressure level (SPL) and lower power consumption.

### 3.3 Expected life

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

## 4. Key Points of Development

In order to develop a product never before seen on the market, we needed to consider how it is actually used. As such, we identified the issues that occur when a fan is used in an environment with high G-force. We also conducted strength analysis using simulation and investigated a new structure. By adopting this new structure based on the analysis results, we successfully produced a fan able to withstand G-forces of up to 75 G.

The key points of development are explained below.

### 4.1 CT scanner application example

Medical CT scanners create cross-sectional images of the body using an X-ray source and detectors that rotate around the patient. Multiple fans are used to cool the detectors.

Currently, there is a demand to shorten the scan time of CT scanners, therefore efforts are being made to increase rotational speed. As such, a fan able to withstand the high levels of G-force that accompany high-speed rotation is required.

Figure 7 illustrates how the new product can be used in a medical CT scanner.

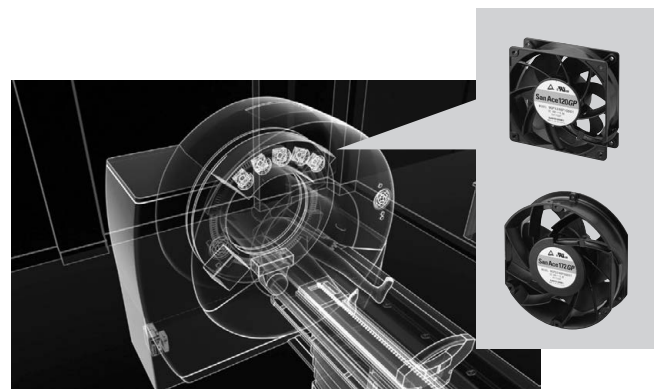


Fig. 7: Example of a fan being used in a medical CT scanner

## 4.2 Ability to withstand G-forces

The ideal product is one that could be used in multiple mounting directions to suit various operating environments. For this reason, we developed a fan that can operate normally even when subjected to G-forces of 75 G from the X, Y or Z axial directions.

Figure 8 shows the directions of G-force able to be withstood by the fan.

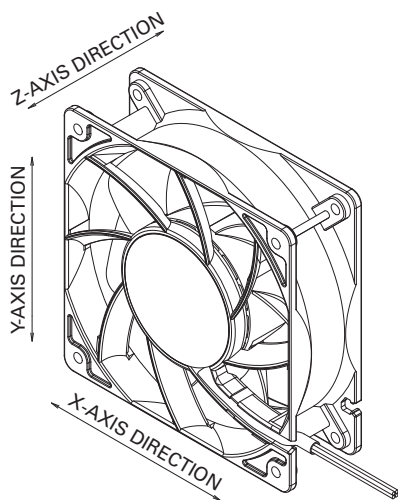


Fig. 8: Withstandable G-force directions

## 4.3 Impeller design

To develop a fan able to tolerate G-forces as high as 75 G, we had to create an impeller structure that could withstand a high load. As such, we employed a structure that integrated the blades and rotor cover. By increasing joint strength, the impeller can withstand a high load.

Figure 9 shows an external view of the new product's impeller.

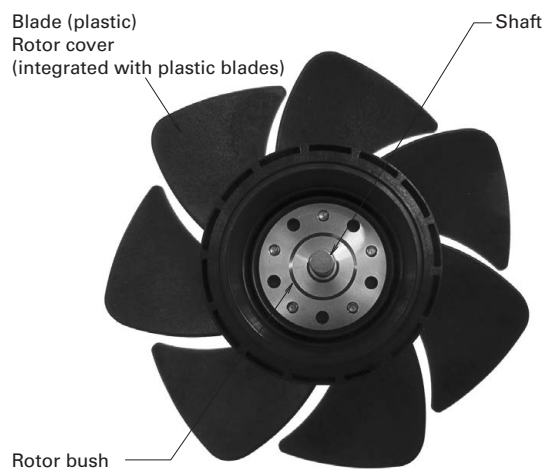


Fig. 9: Impeller of the new product

## 4.4 Frame design

The frame must have high rigidity, so we used an aluminum frame. Moreover, using simulation, we identified where strength needed to be improved and increased strength without sacrificing fan performance, thus ensuring the fan's ability to withstand stress when under a load.

## 4.5. Structural design

For structural design, first we identified the problems that arise in environments subjected to G-force, then conducted simulation analysis to pinpoint where strength needed to be improved. Through this, we improved rigidity by selectively increasing strength.

Below is an overview of the points that have been significantly improved compared with the existing structure.

### (1) Improved rotor bushing rigidity

A rotor bushing is used to join the rotor cover and shaft. To increase rigidity and increase strength, we reviewed the rotor bushing material and fixing method.

### (2) Bearing retention

Fans use bearings to secure rotating parts such as the rotor and impeller.

When a fan is subjected to G-force, its rotating parts are constantly subjected to an opposing force. In order to withstand this force, we designed a structure that secures the bearings to withstand a greater external force than the structure of the existing model.

## 5. Conclusion

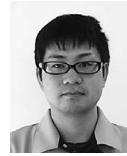
This article has presented some of the features and performance of the 120 × 120 × 38 mm *San Ace 120GP* and ø172 × 150 × 51 mm *San Ace 172GP* 9GP type G Proof Fans developed by SANYO DENKI.

Through adopting a new design with higher rigidity, the new product is capable of withstanding G-forces of up to 75 G and is the industry's first\* product able to withstand G-forces.

We believe this product will not only contribute to cooling of medical devices such as CT scanners, which are increasing in performance and subjecting fans to G-force, but also contribute to the development of new markets.

SANYO DENKI wishes to continue developing products for all kinds of environments and markets, as well as products that contribute to the creation of new value, so that we may provide products that make dreams come true together with our customers.

\* Based on our own research as of August 25, 2017, among equally sized axial DC cooling fans on the market.



### Naoya Inada

Joined SANYO DENKI in 2007.  
Cooling Systems Div., Design Dept.  
Works on the development and design of cooling fans.



### Jiro Watanabe

Joined SANYO DENKI in 1978.  
Cooling Systems Div., Design Dept.  
Works on the development and design of cooling fans.



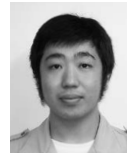
### Atsushi Yanagisawa

Joined SANYO DENKI in 2006.  
Cooling Systems Div., Design Dept.  
Works on the development and design of cooling fans.



### Masato Kakeyama

Joined SANYO DENKI in 2013.  
Cooling Systems Div., Design Dept.  
Works on the development and design of cooling fans.



### Masaki Kodama

Joined SANYO DENKI in 2015.  
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.