"SAN ACE MC" for Pentium®4 1U Server

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1. Introduction

The 1U size server (44.45mm in height), that is the smallest size that can be installed in 19-inch racks, is widespread in the server market. Also common in the information-oriented society has been the improvement of size and thickness for these devices. The usage of the high performance microprocessor (MPU) has also grown accordingly. Meanwhile, technical advancement in the MPU is remarkable, steadily improving the speed, the function, and the integration. With this, heat loss in the MPU has been rapidly increasing as well. In this situation, a thin and highly effective cooling device that can be installed in the 1U server is in great demand.

We have developed and manufactured the "SAN ACE MC" for Pentium®4 1U server to satisfy such a demand.

This paper introduces the outline and the features of the product.

2. Background of the Development

We have manufactured the MPU cooler, "SAN ACE MC" series as a cooling device that cools microprocessors (MPU).[(1), (2)] However, the present product series is too tall in height to install in the thin-type devices such as the 1U server.

So, we have started the development of the thin, high cooling performance "SAN ACE MC" that can be installed specifically in 1U size servers (44.45mm). We have examined not only the conventional aluminum but also highly heat conductive copper for the material of the heat sink. Also, we have designed the shape of the fan motor to accommodate usage in a thin device.

"SAN ACE MC" for Pentium®4 1U server (hereafter, this product) has been developed for the above-mentioned situation.

3. Outline of the Product

Fig.1 shows the "SAN ACE MC" for Pentium®4 1U server and Fig.2 shows the dimensional overview. Table 1 shows the performance overview of this product.

Fig.1 "SAN ACE MC" for Pentium®4 1U server

This product is a cooling device developed exclusively for the Pentium®4 processor in which the cooling fan is integrated with the heat sink. The following are the features of the product.

(1) Sanyo original structure for the fan and the heat sink
(2) Thin design with a net height of 25mm
(3) High cooling performance
(4) High reliability and long life

3.1 Structure

The features on the structure of this product are shown below.

The structure drawing is shown in Fig.3 as well.

(1) The fan is located on the intake side and the heat sink is located on the exhaust side. This structure contributes to improved life of the fan and cooling performance.

(2) The structure of the fan with a thin heat sink of net height 25mm has been realized using the fin shape of the fan and the heat sink.

(3) This product has been designed with the assumption of being utilized in a 1U size (44.45mm) application. The intake area is ensured by improving the frame shape such that even if an obstruction stands close to the fan intake side there is still sufficient intake area.

Table 1 Performance Overview of the "SAN ACE MC" for Pentium®4 1U server

Model	Rated Voltage	Operating Voltage Range	Rated Current	Rated Rotation Speed	Thermal Resistance	Sound Pressure Level	Mass
	[V]	[V]	[A]	[min^{-1}]	[K/W]	[dB(A)]	[g]
109X9412G4016	12	7～13.2	0.29	7600	0.435	52	340

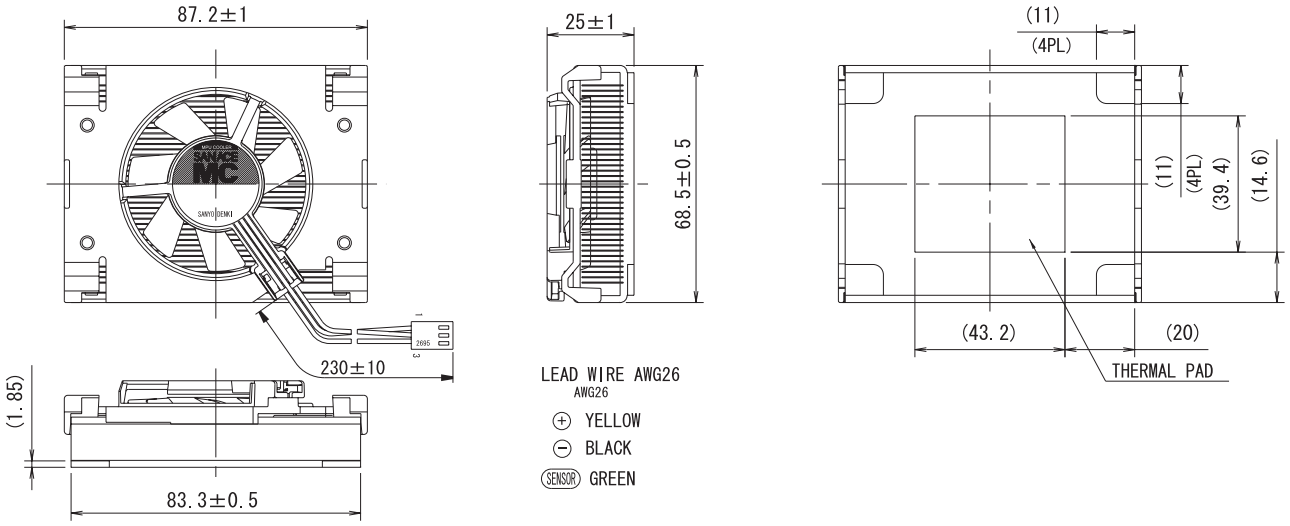

Fig.2 Dimensional Overview of the "SAN ACE MC" for Pentium®4 1U Server

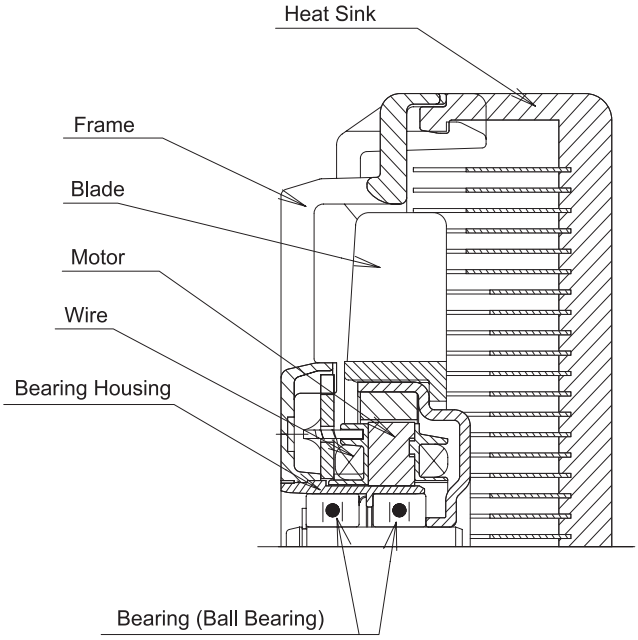

Fig.3 Structure Drawing of the "SAN ACE MC" for Pentium®4 1U Server

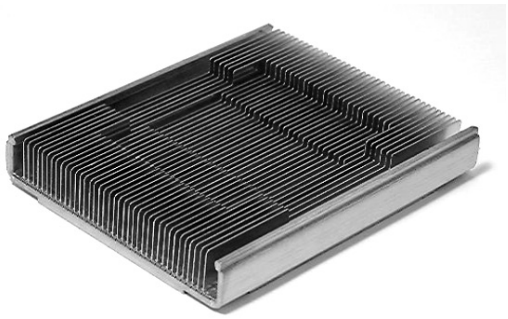

Fig.4 Heat Sink

3.2 Performance

(1) Heat Sink

Copper, with excellent heat conduction, was used for the entire base and all the fins on the heat sink are designed to achieve a high cooling performance.

The structure of cutting grooves for joining the fins in the base was adopted to take into account the usage environment and device needs

Fig.4 shows the heat sink.

The typical parameters which influence the performance of the heat sink are shown below.

① Heat conductivity of the heat sink material
② Radiation area of the heat sink
③ Exhausted air volume that passes through the heat sink

The use of copper, that has excellent heat conductivity, as the heat sink material improves the performance while increasing the mass.

In addition, the radiation area and the exhausted air volume that passes through the radiation area determine the performance of the heat sink.

We also optimized the thickness of the heat sink base, and the thickness, quantity, and shape of the fins – all within the limits of the mass specification.

The heat sink that was designed consists of a copper base (4mm thick) and 38 copper fins (0.3mm thick each). This has proven to demonstrate the highest cooling performance in heat analysis simulation and experimental results.

(2) Fan

The fan installed in the product was designed exclusively for thin-type usage (25mm thickness).

Fig.5 shows the fan.

The fan motor was reduced in height as much as possible and the blades penetrate into the fin area.

The radiation area of the heat sink decreases when the blades penetrate into the fin area, which results in a decrease in cooling performance. To compensate, we optimized the size and shape of the above-mentioned heat sink (base thickness and thickness, quantity, and shape of fins).

Moreover, even if an obstacle stands close to the upper surface of the fan, the fan was designed to secure the passage of air by recessing the venturi below the top surface of the motor. This will guarantee the performance when the fan is installed in thin equipment.

We were able to maintain the fan performance in a thin device (such as 1U size with 44.45mm height) by minimizing the reduction of air volume. We did this by carefully designing the fan including the optimization of the height, shape and quantity of blades for the fan and by recessing the venturi.

As an example, when an obstacle was placed about 2mm away from the intake plane of the fan, heat resistance (a key cooling performance factor) was 0.435K/W. This is about the same cooling performance when there is no obstacle.

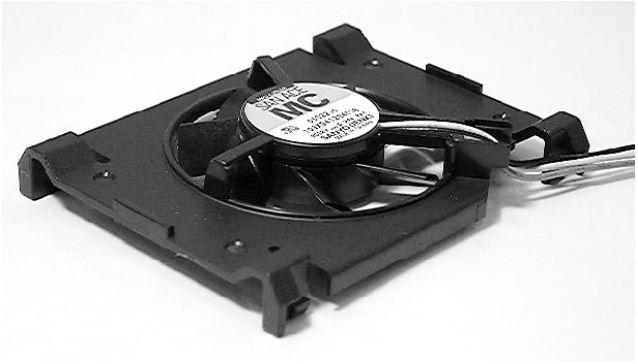

Fig.5 Fan

(3) Comparison With The Conventional Product

The result of comparing the size, the cooling performance, and the mass between this product and the conventional product is shown in Table 2.

Even though the height of this product is approx. 37.5mm (approx. 60%) shorter than the conventional product and the mass is approx. 30g (approx. 8%) lighter, this product produces almost the equivalent heat resistance to the conventional product since we exclusively designed the fan with the improvements stated above.

Table 2 Comparison Table

Model	Size of Exterior [mm]	Mass [g]	Thermal Resistance [K/W]
109X9412G4016	87.2×68.5×25	340	0.435
109X9812H0016	95×71.3×62.5	370	0.420

3.3 Method of Fixing

Two custom clips are used to install this product.

The clip is for the exclusive use as a retention device for Pentium®4 and is designed to be lower than the height of the product when it's assembled to accommodate a 1U server.

Stainless steel of 1mm in thickness is used for the material and it gives sufficient strength to properly hold this product.

The example of the custom clip (model number: 109-1011) is shown in Fig.6 and the clips are shown in Fig.7.

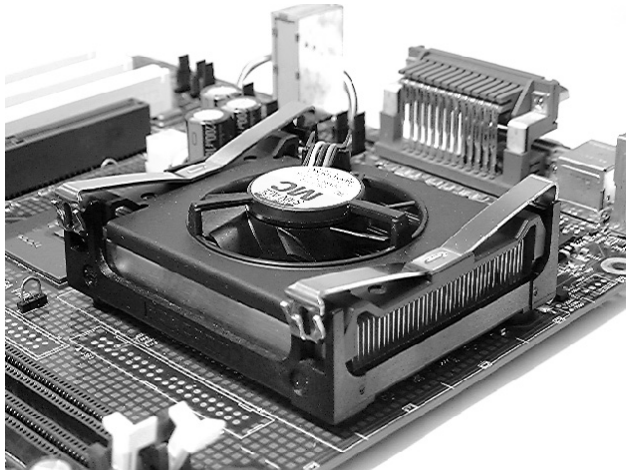

Fig.6 The Usage Example of the Custom Clip (Model No.: 109-1011)

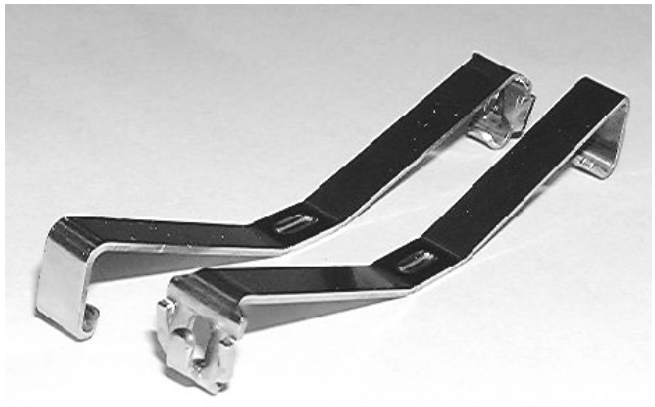

Fig.7 Custom Clips(Model No.: 109-1011)

4. Conclusion

The structure and overview of the performance for the "SAN ACE MC" for Pentium®4 1U Server were introduced. This product can be used in the 1U server application or in any field where a cooling device is required for small and low profile applications.

Microprocessors will continue to get faster with increased heat loss. Because of this, cooling devices that are smaller and have higher cooling performance will be demanded in the future.

* Pentium® in the text is the registered trademark of Intel Corporation

Reference

(1) Ogawara & others: "SAN ACE MC" for Pentium®Ⅲ&Pentium®4 SANYO DENKI Technical Report, No.11 pp5-8 (2001-5).
(2) Watanabe & others: MPU Cooler "SAN ACE MC-HX" SANYO DENKI Technical Report, No.12 pp25-28 (2001-11).

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