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Feature

"SAN ACE MC" for Pentium®Ⅱ*

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1. Introduction

The microprocessors (CPU) used in personal computers have become far more sophisticated in recent years, with higher packing density, speed of operation and performance. As CPU development progresses, the heat density of the CPU rises, hence an efficient cooling device such as a heat sink or combination of fan and heat sink is essential.
CPUs come not only in the conventional chip package type but also in the card type. Pentium® Ⅱ processor of Intel is the latter type. The card is fitted to the motherboard connector of the personal computer in the same way as an extension board (called S.E.C.C: Single Edge Contact Cartridge).
We have developed and put on market "SAN ACE MC" for Pentium® Ⅱ as the cooling device for the above described processor card type CPU. Outline and features are described below.

2. Background of Development

We developed and have been manufacturing CPU cooler "SAN ACE MC" for cooling CPUs. The product lineup of this series includes four models that exhaust the warm air in four directions for desk-top personal computers that have enough space inside, and "SAN ACE MC note" model that exhausts the warm air in one direction and is designed for use in thin devices like notebook personal computers.
The conventional chip package type CPU is installed on the motherboard using a socket, and the CPU cooler is attached to the motherboard and the CPU at a level. Usually, there is sufficient space on both the intake side and exhaust side of the CPU cooler fan. The processor card type CPU is installed on the motherboard at right angles to the board. If the conventional cooling fan that exhausts air in four directions is used with the processor card type CPU, then the exhausted air is blocked by the motherboard. And if two processor cards are used, a processor card will likely be installed in a position that blocks ventilation of the CPU cooler for the other CPU, thus decreasing the cooling performance.
We have therefore developed and released "SAN ACE MC" fan for Pentium® Ⅱ that offers the required cooling performance under such operating conditions.

3. Outline

Fig. 1 shows the outside view of "SAN ACE MC" for Pentium® Ⅱ. Table 1 shows the specifications.
"SAN ACE MC" is a cooling device in which the cooling fan and the heat sink are combined into a single unit, and is designed mainly for Pentium® Ⅱ processor.

"SAN ACE MC" has the following features:

(1) Sanyo Denki's unique ventilation structure of fan and heat sink

(2) Ventilation structure that maintains good cooling performance when installed in equipment

(3) High reliability

(4) Built-in pulse sensor that outputs two pulses for every rotation

(5) Connector for easy installation

Table 1 Specifications of "SAN ACE MC" for Pentium ®Ⅱ

Model number	109X1512H3016	109X1512S3016
Rated voltage (V)	12	
Operating voltage range (V)	10.8 to 13.2	
Rated current (A)	0.06	0.08
Rated input (W)	0.72	0.96
Rated rotation speed (min^{-1})	4000	5000
Thermal resistance (K/W)*1	0.69	0.62
Acoustic noise (dB[A])*2	29	35
Mass (g)	135	
Size (mm)	120×53.4×28.1	

*1: Measured by our system
*2: At 1 m from the intake face of the fan

4. Structure

Fig. 2 shows the dimensions of "SAN ACE MC" for Pentium® Ⅱ. The main features of its structure are as follows.

(1) The heat sink is made of cast aluminum, while the fan case of made of plastics. The fan case and heat sink can be removed by hand.

(2) The fan is located at the air intake side while the heat sink is located at the exhaust side. This structure greatly prolongs the life of the fan and improves the cooling efficiency. The details are described in a separate report. (1)

(3) The ventilation system is such that the air drawn in by the fan and heated by the heat sink is exhausted in two directions.

(4) The heat sink is covered by the fan case, and the fan case on the exhaust side overhangs the heat sink.
Features (3) and (4) described above ensure good cooling performance when the fan is installed in an apparatus.

The causes how these structures contribute to the cooling performance are described in the following chapter.

5. Cooling Performance

5.1 Thermal Resistance Measurement Conditions

The thermal resistance θs-a that indicates the cooling performance of "SAN ACE MC" for Pentium® Ⅱ is given by the following equation.

θs-a = (Tsink-Ta)/P ---(1)

Tsink : Heat sink base surface temperature (℃)

Ta : Air temperature of the fan intake side (℃)

P : CPU heating value(W)

The thermal resistance measurement conditions are shown in Fig. 3. An aluminum plate for heat conduction is placed between the dummy CPU and the heat sink. The heat sink is fixed to the aluminum plate by thermally conductive silicone grease, and the dummy CPU and aluminum plate are kept in close contact with each other by the use of silicone grease. An obstruction wall is installed to act as the other processor card assuming that two processor cards are installed. The distance from the fan intake opening to the obstruction wall is about 10 mm. Amount of heating that is applied to the CPU is around 40W.

Obstruction of the air intake side of a fan can have the following adverse effects:

(1) As the distance from the obstruction to the fan intake opening decreases, the volume of air drawn in by the fan decreases.

(2) The decrease of air volume reduces the air velocity at the exhaust outlet, and hence the heated air can easily start circulating.

5.2 Causes of Decrease in Cooling Performance

Fig. 4 shows the air flow of an ordinary heat sink fan. This heat sink fan consists of an aluminum extruded heat sink in which slits are formed, and an ordinary axial fan that is attached to the heat sink. Its structure is such that the air heated by the heat sink is exhausted in four directions.

In this structure of heat sink fan, the air exhausted to the motherboard is interrupted by the motherboard and the obstruction wall, and so flows into the fan's air intake opening, thus causing negative air pressure. Fig. 4-(a) shows the circulation of air that is heated as it passes through the heat dissipation fin. Because the heat sink that exhausts the heated air in the longitudinal direction does not have a cover, the heated air can start circulating easily as shown in Fig. 4-(b). The circulation of the exhausted air increases the temperature of the air that passes through the heat dissipation fin.

The amount of heat dissipation of the heat sink Q (W) is generally given by the following equation.

$Q=h \cdot S \cdot \Delta T$ ---(2)

h :Heat transfer coefficient ($W/m^2 \cdot K$)

S :Surface area of the heat dissipation fin (m^2)

ΔT : Difference between the temperature of the heat dissipation fin and that of the air passing through the fin (K)

As the temperature of the air passing through the heat dissipation fin rises, ΔT of equation (2) becomes small and the amount of heat dissipation of the fin decreases. As a result, the CPU temperature increases.

5.3 Comparison of Cooling Performance

In order to prevent a reduction in the cooling performance of "SAN ACE MC" for Pentium® Ⅱ as described above, the heated air is exhausted in two directions and circulation of the heated air due to the motherboard and obstruction is avoided. Also, the fan case at the outlet for exhausting into the two directions is extended beyond the heat sink so that the heated air cannot easily circulate.
The cooling performance of the ordinary heat sink fan as shown in Fig. 4 is decreased by about 30% when an obstruction is installed, while the cooling performance of "SAN ACE MC" for Pentium® Ⅱ is reduced by only 7%. Thus "SAN ACE MC" for Pentium® Ⅱ has superior cooling characteristics when an obstruction is installed, such as when Pentium® Ⅱ is mounted.

6. Conclusion

We have described the main features of our "SAN ACE MC" for Pentium® Ⅱ that extends the "SAN ACE MC" lineup.
"SAN ACE MC" for Pentium® Ⅱ has a unique air blow system in order to deliver good cooling performance when installed in apparatus. As personal computers and other electronic apparatus become higher performance and more compact, internal cooling will become more difficult. Demands for a cooling system that considers the installed state in apparatus will increase in the future.

References

(1)Ogawara and others: Development of "SAN ACE MC" for CPU Cooling, SANYO DENKI Technical Report,No1,pp.9-14(1996-5)

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Fig.3 Thermal resistance measurement conditions

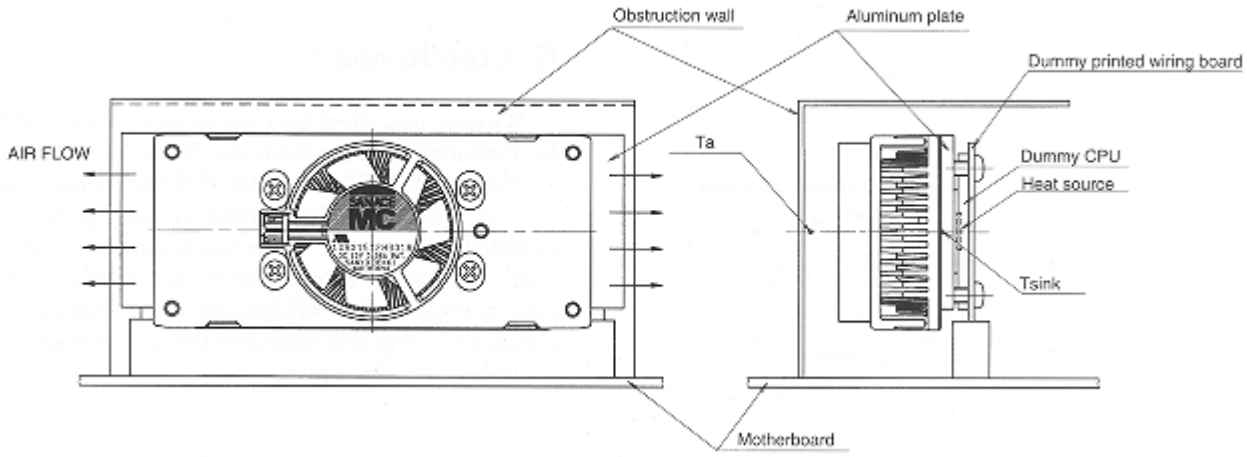

Fig.4 Air flow of an ordinary heat sink fan