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Feature

"SAN ACE MC" for Pentium®Ⅲ & Pentium®4

Toshiki Ogawara Tomoaki Ikeda Haruhisa Maruyama
Masashi Miyazawa

1. Introduction

In recent years, PCs and other information equipment have been growing in speed and functionality, resulting in a rising trend in the heating value of the entire equipment.

With the size reduction and thinning of the equipment, the heat density of the inside of the equipment continues to rise year by year.

Particularly eye-catching is the rate at which microprocessors (MPUs), which are the brain of the computer, are making technical advances. They have never stopped rising in speed, functionality and integration. On the other hand, microprocessors are growing in heating value, with their heat densities rising particularly quickly. Cooling for microprocessors is even more important than ever before, so that demand is high for efficient, high-performance, and silent coolers.

To meet these demands, this company has developed and commercialized the "SAN ACE MC" for Pentium®Ⅲ, the "SAN ACE MC" for Pentium®4, and the "SAN ACE MC" that can be installed in thin equipment. This paper outlines this series of products and presents its features.

2. Background of development

Sanyo Denki has commercialized MPU coolers of the "SAN ACE MC" series, as coolers that cool microprocessors.

The line-up consists of the "SAN ACE MC" series designed to cool desktop PCs and the "SAN ACE MC note" series designed mainly to cool notebook PCs and other thin equipment[(1), (2)]

Ever-faster, ever-higher-functionality microprocessors are rising not only in heating value but in heat density as well at a quick rate. Coolers have come to need some ideas to disperse local heat-up. The "SAN ACE MC" for Pentiumand®Ⅲ Pentium®4, which we have now developed, employs a high-density extrusion heat sink. Some models use a copper heat sink to achieve high cooling performance.

Now that the age of the Internet has arrived, the size reduction of equipment is even further accelerated. We have then developed and commercialized thin "SAN ACE MC" for Pentium®Ⅲ , a cooler that can be contained in 1U servers and other thin equipment and display high cooling performance.

3. Product overview

Fig. 1 gives an external view of a typical model of the "SAN ACE MC" for Pentium®Ⅲ , a cooler which we have now developed and commercialized. Fig. 2 is an external view of the "SAN ACE MC" series for Pentium® 4, and Fig. 3 is an external view of the "SAN ACE MC" series for Pentium®Ⅲ . Tables 1, 2, and 3 give the performance specifications of each product.

This product is a cooler that combines a cooling fan with a heat sink in one unit and has been developed specifically for Pentium® Ⅲ and Pentium® 4 processors.

Given below are the features of the product.

(1)Fanning structure of Sanyo's original fan and heat sink

(2)High cooling performance

(3)High cooling performance as assembled on host equipment

(4)Low noises

(5)High reliability, long service life

3.1 Structure

Described below are the structural features of the "SAN ACE MC", which we have developed and commercialized.

(1) A fan is installed on the air intake, while a heat sink is on the exhaust. This structure helps increase the fan's life and cooling performance.

(2) The frame is so shaped as to allow sufficient air to go through even if an obstruction is placed close to the fan intake. This suppresses the fan's decline in air volume and reduces the impact on cooling performance when the cooler is actually contained in host equipment.
Particularly effective in that sense is the thin "SAN ACE MC" for Pentium® Ⅲ .
In the case of 109X7612S2016, the thermal resistance of a cooler without an obstruction is 0.9K/W, as opposed to about 0.99K/W even when there is an obstruction about 1mm above the fan intake. The impact is thus only about 10%.

(3) In some models, the fan contains a temperature-sensing thermistor to detect the fan intake temperature and change the fan rotating speed automatically, thus reducing the noise level of the host equipment during an actual run.

3.2 Performance

(1) Heat sink

Fig. 4 is an external view of a typical heat sink.

The heat sink we used for this project is made of high-density extruded aluminum. As opposed to the conventional aspect ratio (the ratio of fin height to fin-to-fin clearance) of no more than 10, the present product has about 12, which means a narrower fin-to-fin clearance and a larger radiation area.

To transfer heat well with the radiator fin, the base has been thickened to promote thermal conductivity.

The heat sink for the "SAN ACE MC" for Pentium® 4 is given 8 or 9 local slits that cut the fin and base together. These slits increase the cooling performance by about 0.05K/W. This is because a cooling air stream sucked from the fan flows through the heat sink base. The absence of slits in all fins is due to the fact that slitting inhibits heat conduction. A particularly high impact is exercised on cooling performance by slitting the middle fin.

Some models have heat sink bases made of highly thermal conductive copper and heat sinks equipped with 0.4mm thick aluminum fins. Cooling performance is even higher than models incorporating extruded heat sinks.

Table 1 Performance specifications for "SAN ACE MC" for Pentium®Ⅲ

Model No.	Rated voltage [V]	Operating voltage range [V]	Rated current [A]	Rated rotating speed [min^{-1}]	Thermal resistance [K/W]	Sound pressure level [dB(A)]	Mass [g]
109X7612T5S016	12	7 to 13.8	0.17	4800 3600	0.64 0.71	38 28	230
109X7612S5016			0.17	4800	0.64	38	
109X7612H5016			0.1	3900	0.69	31	

Note: On the 109X7612T5S016, fan rotating speed varies with the intake temperature between 35°C and 47 °C.

Table 2Performance specifications for "SAN ACE MC" for Pentium® 4

Model No.	Rated voltage [V]	Operating voltage range [V]	Rated current [A]	Rated rotating speed [min^{-1}]	Thermal resistance [K/W]	Sound pressure level [dB(A)]	Mass [g]
109X9612T5S016	12	9 to 13.8	0.23	5000 3200	0.44 0.52	40 28	270
109X9612S5016			0.23	5000	0.44	40	
109X9612A5016			0.13	4400	0.46	36	
109X9612H5016			0.1	3600	0.5	31	
109X9712T5S016	12	9 to 13.8	0.23	5000 3200	0.4 0.49	42 29	450
109X9712S5016			0.23	5000	0.4	42	
109X9712A5016			0.13	4400	0.42	37	

Note: On the 109X9612T5S016 and 109X9712T5S016, fan rotating speed varies with the intake temperature between 35°C and 45°C.

Table 3Performance specifications for "SAN ACE MC" for thin Pentium®Ⅲ

Model No.	Rated voltage [V]	Operating voltage range [V]	Rated current [A]	Rated rotating speed [min^{-1}]	Thermal resistance [K/W]	Sound pressure level [dB(A)]	Mass [g]
109X7612S2016	12	7 to 13.8	0.17	4800	0.9	38	130
109X6512A2016			0.07	4800	1.15	35	110

(2) Fans

The fans contained in the product have been developed specifically for specific models.

A particularly imaginative idea used is that for fans to display their maximum performance when contained in host equipment, the venturi is recessed somewhat below the label surface on the boss of the motor, so that even when an obstruction is installed above the fan, a minimum required air passage is secured. In addition, the blade shape, blade-to-spoke distance, blade-to-fin distance, the shape of the spoke base, and other factors have been optimized to increase air volumes and cut noise levels. These considerations have enabled the fans in the "SAN ACE MC" for Pentium ® 4 to achieve air volumes equal to those of this company's BLDC fans 60mm sq.x 25mm thick.

(3) Thermal speed controlled fans

In some models, the fan is equipped with a temperature-sensing thermistor to detect the intake temperature of the fan. The rotating speed of the fan is varied to cut noise levels during actual operation.

Fig. 5 shows the relationship between the intake temperature and rotating speed of a typical fan.

Usually, such a microprocessor cooler is used that does not surpass the top limit operating temperature of microprocessors at the top limit of the operating environment of the host equipment.

In the case of the "SAN ACE MC" for Pentium® 4, for example, assuming that the heating value of the microprocessor is 50W, the top limit operating temperature of the microprocessor is 67°C, and the top limit inner temperature of the host equipment is 45°C, then the thermal resistance required for the cooler is (67-45)/50=0.44 K/W.

The "SAN ACE MC" selected at that time was the 109X9612S5016, with a thermal resistance of 0.44K/W and a noise level of 40dB(A). In an actual operating environment for host equipment, the ambient temperature of the "SAN ACE MC" rarely becomes 45 °C. In reality, it is generally around 30°C.

Assuming that the internal temperature of the host equipment is 30°C, the performance requirements can be calculated as follows: Thermal resistance is 0.74K/W and a 109X9612H5016 (with a thermal resistance of 0.5K/W) is sufficient to cool the host equipment. In that case, the noise level is about 9dB(A) lower than 109X9612S5016, but considering the worst case scenario of the operating environment for the host equipment raises some concerns over the cooling of microprocessors.

Added to the line-up to solve these problems is the "SAN ACE MC", which incorporates the functions of a thermally speed controlled fan.

On the 109X9612T5S016, the noise level becomes 28dB(A) because it runs at low speed when the intake temperature of the fan is 35°C. As the intake temperature of the fan rises, the rotating speed of the fan goes up. At 45°C and higher, it runs at high speed, with a noise level of 40dB(A).

Thus, this cooler is silent under actual operating conditions, but is capable of cooling microprocessors at the top limit operating conditions of the host equipment.

4. Conclusion

We have so far introduced a part of the structure and performance of the newly developed and commercialized "SAN ACE MC" for Pentium®Ⅲ , Pentium® 4, and thin type "SAN ACE MC" for Pentium®Ⅲ.

Microprocessors are expected to continue increasing in performance and speed, thus further rising in heating value and heat density.

Under these circumstances, there is expected to be demand for coolers that are smaller in size, higher in cooling performance, and lower in noise level.

* Pentium® in the text is a registered trademark of Intel Corp.

References

(1) Ogawara et al.: Development of MPU Coolers, "SAN ACE MC" SANYO DENKI Technical Report, No. 1 p9-14 (1996-5).

(2) Watanabe et al.: "SAN ACE MC note" SANYO DENKI Technical Report, No. 4 p23-25 (1997-5).

Toshiki Ogawara
Joined company in 1984
Cooling Systems Division, Design Dept.
Worked on development and design of "SAN ACE MC"

Haruhisa Maruyama
Joined company in 1997
Cooling Systems Division, Design Dept.
Worked on development and design of "SAN ACE MC"

Tomoaki Ikeda
Joined company in 1990

Cooling Systems Division, Design Dept.
Worked on development and design of "SAN ACE MC"

Masashi Miyazawa
Joined company in 1998
Cooling Systems Division, Design Dept.
Worked on development and design of "SAN ACE MC"

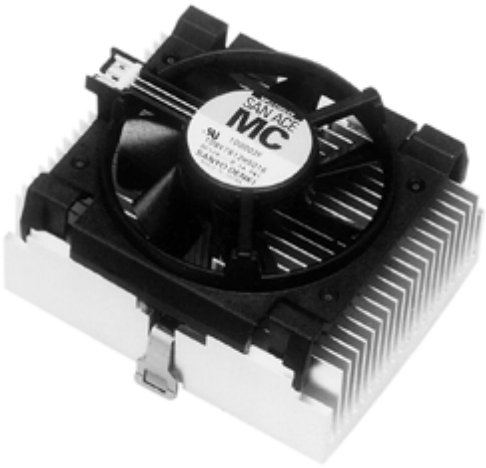

Fig.1 "SAN ACE MC" for Pentium® Ⅲ

Fig.2 "SAN ACE MC" series for Pentium®4

Fig.3 Thin "SAN ACE MC" series for Pentium®Ⅲ

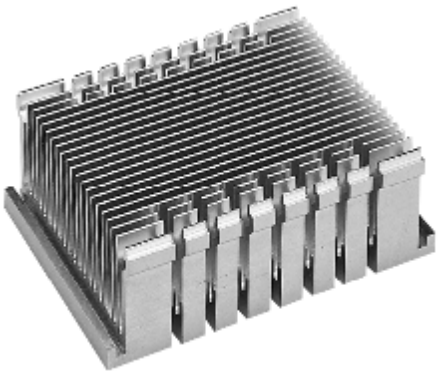

Fig. 4 External view of a typical heat sink (109X9612T5S016)

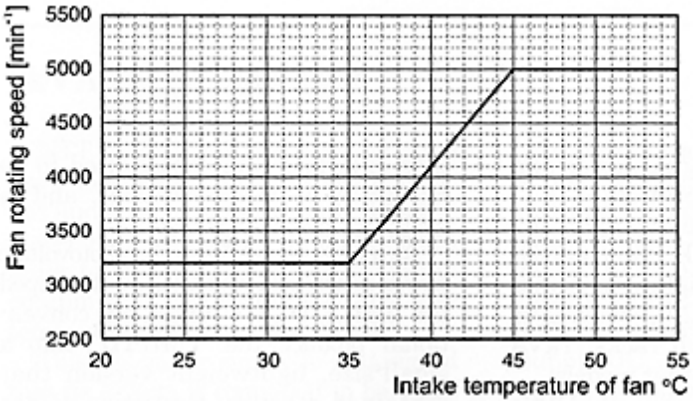

Fig. 5 Relationship between intake temperature and fan rotating speed (109X9612T5S016)