Thermal Test

Results for the

COFAN Model WAK5012BO3

CPU Cooler made for

Intel Celeron (PPGA & FC-PGA), Intel Pentium III (FC-PGA), & AMD K6 Series (PPGA)

Microprocessor

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1.0 Objective

The objective of this document is to explain to the computer industry how the COFAN model WAK5012BO3 CPU cooler exceeds the requirements for the Intel Celeron™ (PPGA & FC-PGA), Intel Pentium III™ (PPGA), & AMD K6 Series (PPGA) microprocessors in various thermal environments.

2.0 Scope

The purpose of this section is to define the commercial test equipment and test methodology used to thermally test the COFAN model WAK5012BO3.

2.1 Commercial Test Equipment

2.1.1 Thermotek Digital Thermometer, model D9013
2.1.2 LG Thermal Chamber, model T9031
2.1.3 Hewlett-Packard, Oscilloscope, model HP1740A
2.1.4 WanLass DC Power Supply, model Maverick II
2.1.5 Ono Sokki Digital Tachometer, model HT-1410
2.1.6 Fan Specification

FEATURE	SPECIFICATION
Size	50 x 50 x 12 mm
Air Flow	12.8 CFM at 5100 RPM
Air Pressure	3.0 mmH_2O
Acoustic noise	26 dB
Input power	12VDC, max 0.11A
Tachometer Sensor output	Open collector,TTL signal,2 pulses/rev
MTBF at 25 °C	100,000Hrs.

3.0 Test Procedure

The test procedure is compliant with Intel Application Note, AP-586 that defines how to thermally test heat evacuation devices for microprocessors.

3.1 Cooler to CPU Mechanical Interface

3.1.1 The WAK5012BO3, shown in Figure 6.0 is manufactured to sufficiently tight tolerances that no thermal compound or thermal tape is required on the cooler to CPU mounting surface. The flatness of this interface is held to 0.001 inch TIR. This eliminates the inconvenience and cost of dealing with chemical compounds or thermal tapes.

3.2 Test Samples

3.2.1 Five different WAK5012BO3 CPU coolers were used in the test program.

3.3 Fan Failure Definition

3.3.1 A fan failure is defined as a change in revolutions per minute RPM, by more than 20% from its natural speed.

4.0 General Description

The test procedure utilizes the equipment defined in paragraph 2.1 and five COFAN WAK5012BO3 CPU coolers. All temperature measurements are in Celsius. A total of 240 data sets were taken using five different coolers.

4.1 Microprocessor Thermal Requirements

4.1.1 Each of the three microprocessors has specific maximum upper limit operational temperatures. Please refer to chart 4.1.1 below for details. The reliability of the microprocessor is enhanced if the temperature of the device is well below that limit. The 40+watt dissipation of each microprocessor can cause its thermal interface to exceed the maximum operating temperature if insufficient cooling is provided.

Chart 4.1.1

MICRO-PROCESSOR	SPEED (MHZ)	MAX WATTS	TC TEMP(^{O}C)	RECOMMENDED COFAN PART #	ACTUAL TC TEMP AT AMBIENT		PASSIVE NO.
					40^{O}C	45^{O}C	
Intel Celeron (PPGA)	300A	17.8	85	WAK5012BO3	50.7	55.7	N/A
	333	19.7	85	WAK5012BO3	51.8	56.8	N/A
	366	21.7	85	WAK5012BO3	53.0	58.0	N/A
	400	23.7	85	WAK5012BO3	54.2	59.2	N/A
	433	24.1	85	WAK5012BO3	54.4	59.4	N/A
	466	25.6	70	WAK5012BO3	55.3	60.3	N/A
	500	27.0	70	WAK5012BO3	56.2	61.2	N/A
	533	28.3	70	WAK5012BO3	56.9	61.9	N/A
Intel Celeron (FC-PGA)	533A	11.2	90	WAK5012BO3	46.7	51.7	N/A
	566	11.9	90	WAK5012BO3	47.1	52.1	N/A
	600	12.6	90	WAK5012BO3	47.5	52.5	N/A
	633	16.5	82	WAK5012BO3	49.9	54.9	N/A
	667	17.5	82	WAK5012BO3	50.5	55.5	N/A
	700	18.3	80	WAK5012BO3	51.0	56.0	N/A

Chart 4.1.1 cont.

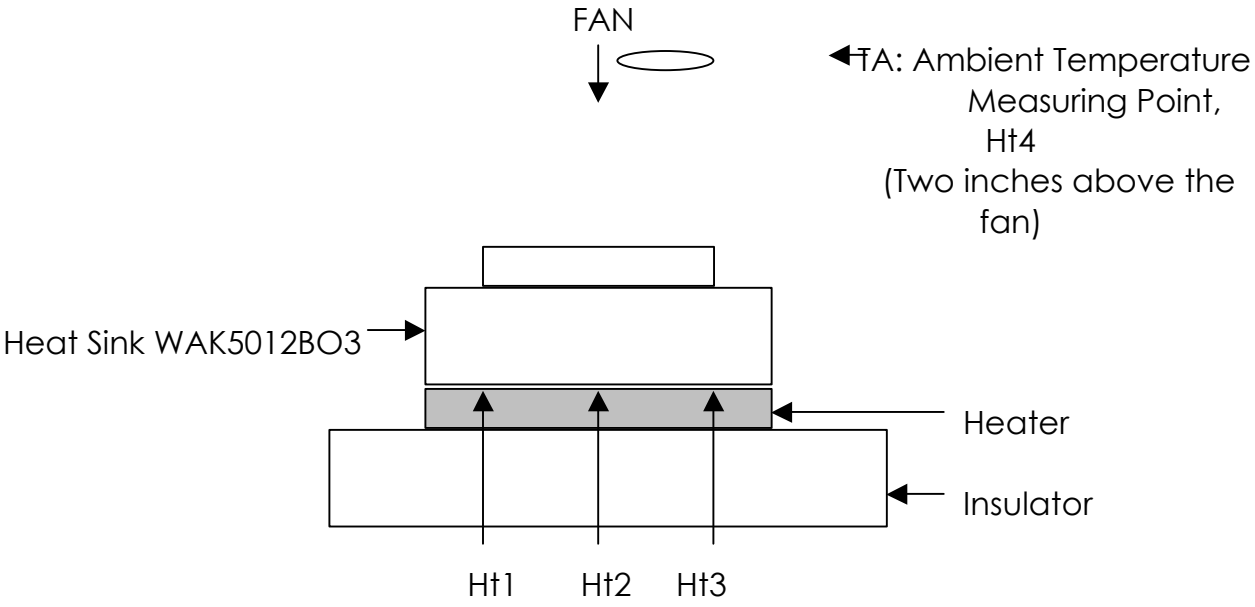
MICRO-PROCESSOR	SPEED (MHZ)	MAX WATTS	TC TEMP(°C)	RECOMMENDED COFAN PART #	ACTUAL TC TEMP AT AMBIENT		PASSIVE NO.
					40°C	45°C	
Intel Pentium III (FC-PGA)	500E	13.2	85	WAK5012BO3	47.9	52.9	N/A
	533EB	14.0	85	WAK5012BO3	48.4	53.4	N/A
	550E	14.5	85	WAK5012BO3	48.7	53.7	N/A
	600E	15.8	82	WAK5012BO3	49.5	54.5	N/A
	600EB	15.8	82	WAK5012BO3	49.5	54.5	N/A
	650	17.0	82	WAK5012BO3	50.2	55.2	N/A
	667	17.5	82	WAK5012BO3	50.5	55.5	N/A
	700	18.3	80	WAK5012BO3	50.9	55.9	N/A
	733	19.1	80	WAK5012BO3	51.4	56.4	N/A
	750	19.5	80	WAK5012BO3	51.7	56.7	N/A
	800	20.8	80	WAK5012BO3	52.5	57.5	N/A
	800EB	20.8	80	WAK5012BO3	52.5	57.5	N/A
	850	22.5	80	WAK5012BO3	53.5	58.5	N/A
	866	22.9	80	WAK5012BO3	53.7	58.7	N/A
	933	24.5	75	WAK5012BO3	54.7	59.7	N/A

MICRO-PROCESSOR	SPEED (MHZ)	MAX WATTS	TC TEMP(°C)	RECOMMENDED COFAN PART #	ACTUAL TC TEMP AT AMBIENT		PASSIVE NO.
					40°C	45°C	
AMD K6 (PPGA)	166	17.20	70	WAK5012BO3	50.3	55.3	N/A
	200	12.45	70	WAK5012BO3	47.5	52.5	N/A
	233	13.50	70	WAK5012BO3	48.1	53.1	N/A
	266	14.55	70	WAK5012BO3	48.7	53.7	N/A
	300	15.40	70	WAK5012BO3	49.2	54.2	N/A
AMD K6-2 (PPGA)	266	14.70	70	WAK5012BO3	48.8	53.8	N/A
	300	17.20	70	WAK5012BO3	50.3	55.3	N/A
	333	19.00	70	WAK5012BO3	51.4	56.4	N/A
	350	19.95	70	WAK5012BO3	51.9	56.9	N/A
	366	20.80	70	WAK5012BO3	52.4	57.4	N/A
	380	21.60	70	WAK5012BO3	53.0	58.0	N/A
	400	22.70	60	WAK5012BO3	53.6	58.6	N/A
	450	18.80	65	WAK5012BO3	51.3	56.3	N/A
	475	19.80	65	WAK5012BO3	52.0	57.0	N/A
	500	20.75	65	WAK5012BO3	52.4	57.4	N/A
	533	20.75	70	WAK5012BO3	52.4	57.4	N/A
	550	25.00	70	WAK5012BO3	55.0	60.0	N/A
AMD K6-3 (PPGA)	400	18.1	70	WAK5012BO3	50.8	55.8	N/A
	450	20.2	65	WAK5012BO3	52.1	57.1	N/A

4.2 CPU Cooler Performance

4.2.1 The ambient cooling air of the computer system is the source of the cooling input. The cooler should keep the thermal interface to the microprocessor as close to ambient as possible.

4.3 Thermal Measurement points



Temperature Measuring Points
Figure 4.3

4.3.1 Four measurement sensors were utilized throughout the tests. One was placed at the ambient air inlet of the cooling fan. Three were distributed across the hot plate that mates with the machined surface of the CPU cooler.

4.4 Thermal Calculations

4.4.1 Ht1, Ht2, Ht3 : three hot plate sensors
Ht4 : TA
TA : ambient input to the fan
Pwr : power applied from the hot plate
The thermal resistance coefficient formula is [(Ht1 + Ht2 + Ht3)/3 - TA]/Pwr. The resultant would be defined as degrees Celsius/watt. The smaller the number, the more efficient the cooler.

4.5 Test Approach

4.5.1 The thermal coefficient of the CPU cooler was determined from measurements taken at five different ambient air inputs from 15°C to 45°C. Data was taken at 5°C increments. At each ambient temperature the hot plate was varied in temperature by increasing the power input in five steps. The power was stabilized at certain levels before measurements were made. The highest level represents the normal operating range for each microprocessor.

5.0 Test Results

5.1 Fan Failures

5.1.1 There were no RPM variations detected of the WAK5012BO3 cooler fans (Model: D5012A12HO) during the test program.

5.2 Test Data

5.2.1 The thermal coefficient data from the tests are illustrated in Table 5.2.1 below.

Intel Celeron

POWER INPUT	THERMAL COEFFICIENT (°C/WATT)					
Watts	Cooler #1	Cooler #2	Cooler #3	Cooler #4	Cooler #5	Avg.
11.2	0.5991	0.5999	0.5993	0.5992	0.5997	0.5994
11.9	0.5994	0.6005	0.5994	0.6004	0.5991	0.5997
12.6	0.5999	0.5992	0.5999	0.6001	0.5999	0.5998
16.5	0.5998	0.5997	0.5997	0.5997	0.6003	0.5997
17.5	0.5997	0.5997	0.5999	0.5997	0.5998	0.5996
18.3	0.5996	0.5996	0.5994	0.5998	0.5997	0.5999
Avg.	0.5996	0.5997	0.5996	0.5998	0.5997	**0.5997**

Intel Pentium III

POWER INPUT	THERMAL COEFFICIENT (°C/WATT)					
Watts	Cooler #1	Cooler #2	Cooler #3	Cooler #4	Cooler #5	Avg.
13.2	0.5999	0.5991	0.5993	0.5994	0.5999	0.5995
14.5	0.6005	0.5994	0.5994	0.5997	0.5996	0.5997
15.8	0.5992	0.5999	0.5997	0.5999	0.5994	0.5996
17.5	0.5997	0.5998	0.5996	0.5997	0.5998	0.5997
19.1	0.5997	0.5997	0.5993	0.5998	0.5996	0.5996
20.8	0.5996	0.5997	0.5997	0.5996	0.5997	0.5996
22.5	0.5994	0.5994	0.5991	0.5992	0.5993	0.5993
24.5	0.5999	0.5996	0.5993	0.5993	0.5998	0.5996
Avg.	0.5996	0.5993	0.5995	0.5996	0.5997	0.5996

5.2.1

5.2.1 cont.

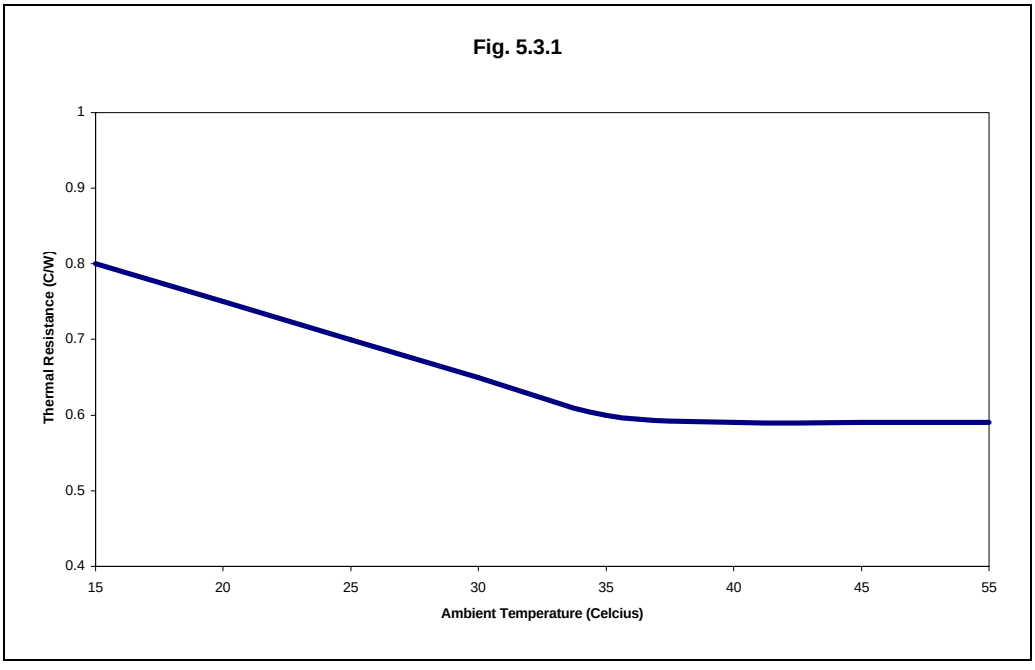
AMD K6 Series

POWER INPUT	THERMAL COEFFICIENT (°C/WATT)					
Watts	Cooler #1	Cooler #2	Cooler #3	Cooler #4	Cooler #5	Avg.
19.0	0.5999	0.5991	0.5993	0.5997	0.5992	0.5994
20.8	0.6005	0.5994	0.5994	0.5991	0.6004	0.5997
22.7	0.5992	0.5999	0.5999	0.5999	0.6001	0.5998
19.8	0.5997	0.5998	0.5997	0.6003	0.5997	0.5998
25.0	0.5996	0.5997	0.5994	0.5998	0.5998	0.5996
Avg.	0.5997	0.5996	0.5995	0.5997	0.5998	0.5997

5.3 Thermal Coefficient Variance versus Temperature

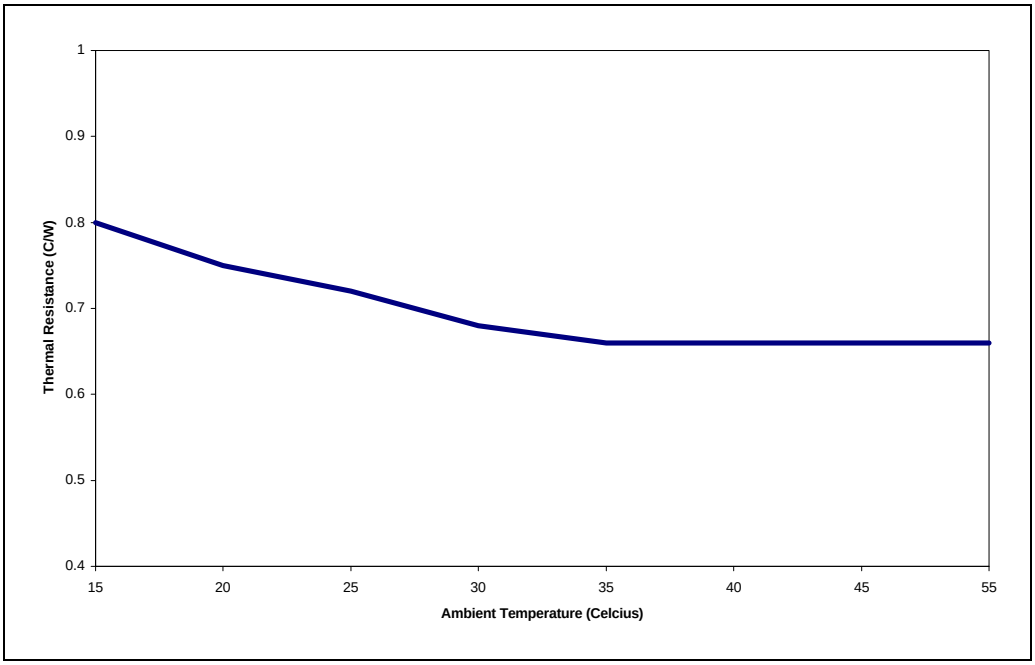
5.3.1 The average thermal coefficient varied over the 15°C to 45°C range at the various power levels. In order to determine where the coefficient stabilized, further tests were conducted to 55°C. At about 35°C the coefficient stabilized at about 0.59 °C/watt. The graph shown below illustrates the test data gathered.

Fig. 5.3.1



5.3.1 cont.

Intel Pentium III



AMD K6 Series

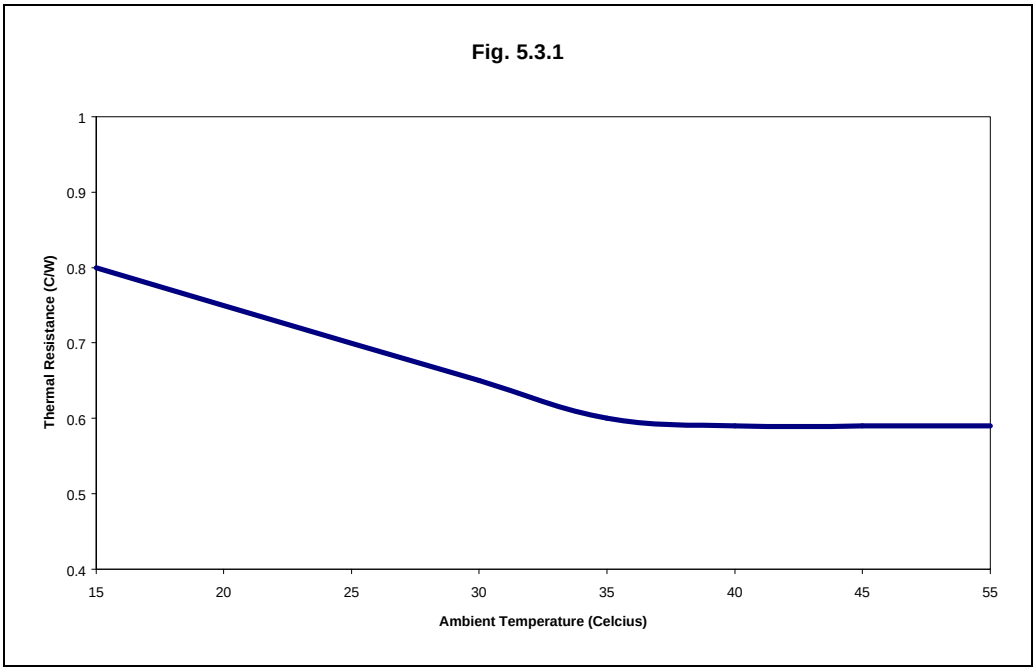


Fig. 5.3.1

6.0 Conclusions

Test results show that the COFAN Model WAK5012BO3 CPU Cooler provides excellent cooling capacity for all three microprocessors. The 0.59 °C/watt thermal resistance coefficient provides for only a 10.8°C rises in temperature for the Intel Celeron. There is a 14.7 °C rise in temperature for the AMD K6 Series and Intel Pentium III. Most computer environments exist at less than 30°C. The temperature within the WAK5012BO3 is well below the maximum operating temperature for each of the processors and should provide failure-free environment for the life of the computer.

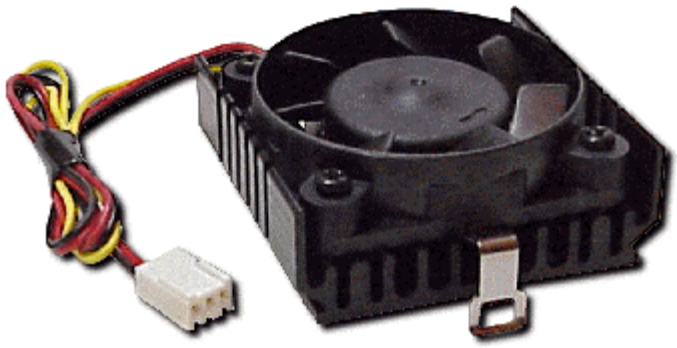


Figure 6.0. COFAN WAK5012BO3 CPU Cooler for the Intel Celeron (PPGA &FC-PGA), Intel Pentium III (FC-PGA), & AMD K6 Series (PPGA)