Report on the Thermal Testing of the

Extra Computer*
D3222* µATX Desktop

Lab. Ref: Fujit29

Thermal Specification **(as per Intel Thermal Specifications)**

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1. INTRODUCTION

1.1. Introduction

This document details thermal tests carried out on the **Extra Computer* D3222* µATX Desktop System.**

Testing was carried out to customer's specification which required monitoring of a number of specific components. Details of these monitor points are provided in section 4.8

The testing was carried out by INTEL CORPORATION (UK) LTD at their Engineering test facilities located at

Intel Corporation (UK) Ltd
Pipers Way
Swindon
Wiltshire
England
SN3 1RJ

This report also details the configuration of the equipment under test, the test methods used and any relevant modifications where appropriate.

1.2. Documentation Review & Approval

Date of Test Completion: 28th May 2013

Date of Report: 4th June 2013

Test Engineer

Colin Lee

2. Summary of Issues

A summary of thermal related test issues is given below. A priority has been assigned to each problem to estimate the potential impact to users. Additionally, there may be some issues that are identified in this report as “FYI” (For Your Information) that may be of interest, but are not considered of high enough priority to be listed in the summary.

2.1. Test Result

The system **PASSES** tests to Intel Thermal Specifications in the configuration detailed in Section 3.3 using the **Intel® Core™ i5-4670K Processor (Q-Spec) (6M Cache, up to 3.80 GHz).**

System temperatures were recorded at both 35 and 45 degree Celsius external ambient during the following test states:

- System idle
- Intel Power Thermal Utility
- FTS System Test

2.2. Priority 1 Critical

- [Issues that must be corrected]
  - None

2.3. Priority 2 Important

- [Issues that should be considered for improvement, but not critical to the system passing]
  - None

2.4. Priority 3 Future Impact

- [Issues that have little impact now. Some may have future impact]
  - None

2.5. FYI Items

- [For Your Information. Miscellaneous information that may be of interest]
  - None

3. System Configuration

This section lists the original configuration of the equipment under test. If any changes are required for the system to pass thermal test specification, these will be stated in section 2.1, and only the system in this configuration is recognized as a qualifying result.

3.1. Equipment Under Test (EUT)

Figure 3-1 Extra Computer D3222 µATX System

3.2. Thermal Solution

Figure 3-2 AVC Fan Heatsink Thermal solution

3.3. EUT Configuration

Manufacturer	Description	Model/Part Number	Serial Number	Location
Exone*	Micro Exone µATX System Chassis	PC31 v.2	059317P1239Y00069	N/A
FSP*	350W ATX 12v PSU 80+ Bronze*	FSP350-60APN / 9PA350AN01	S2321200061	Top rear of chassis
Fujitsu*	µATX Motherboard with Intel® Q87 Chipset	FTS D3222-B12 GS51	41338582	N/A
Intel	Intel® Core™ i5-4670K Processor (Q-Spec) (6M Cache, up to 3.80 GHz)	CM8064601464506	[N/A]	LGA1150
Samsung*	2x2GB DDR3-SDRAM PC3-12800 (800MHz) - [1600]	M378B5773CH0-CK0	E7500138h E7500139h	Channel A DIMM 1 Channel B DIMM 2
Seagate*	Barracuda* 7200RPM 250GB SATA-III 16MB	ST250DM000-1BD141	9VYKFQ3J Rev.FJK2	Internal 3.5" Drive Bay
TSST Corp*	CD/DVD optical Drive ROM SATA II	DVD-ROM SH-116AB	R8UP68BCB00BLQ	Internal 5.25" Drive Bay

BIOS Revision	D3222-B1x V4.6.5.4 R0.91.0 04/16/2013
Operating System	Microsoft* Windows* 7 Professional (Service Pack 1)
Video Resolution	1920 by 1080 pixels

Additional information for fans, ferrites, etc fitted in the chassis

Manufacturer	Description	Model/ Part Number	Position in chassis
Asia Vital Components*	Processor Heat Sink fan	Z8UJ008001	LGA 1150 Socket
EKL*	Rear 80mm Chassis exhaust fan	FD 128025 LS-N	Rear of Chassis

Additional parts supplied with the chassis/system for test

Manufacturer	Description	Model/ Part Number	Position in chassis

4. Test Methodology

4.1. Thermal Test Equipment

Some or all of this equipment may have been used during thermal testing.

Supplier	Description	Model/Part Number
Thermotron*	Walk-In Thermal Chamber	WP-499-THCM-705
Thermotron	Thermal Chamber	S-8SLE
National Instruments*	Compact DAQ chassis	NI cDAQ-9172
National Instruments	Thermocouple input module	NI 9211
Cambridge Accusense*	Airflow Monitoring Equipment	ATM-24 CAFS-220-5M
Testo*	Digital Anemometer	0560.4900
Anville Instruments*	Data Acquisition Unit	X-435
Fluke*	Hydra Data Logger	2625A
Fluke	Thermocouple Calibrators	51/52 & 714 Series
FLIR Systems*	Infra-Red Camera	Thermacam* S40
Omega*	Hot-Point Cell	CL950-220

Table 4-1

4.2. Tolerance/Accuracy

All thermal test equipment is maintained annually by traceable calibration.
The accuracy of type T thermocouples is: -270 to +400ºC, greater of 0.5ºC or 0.4%.

4.3. Test Method

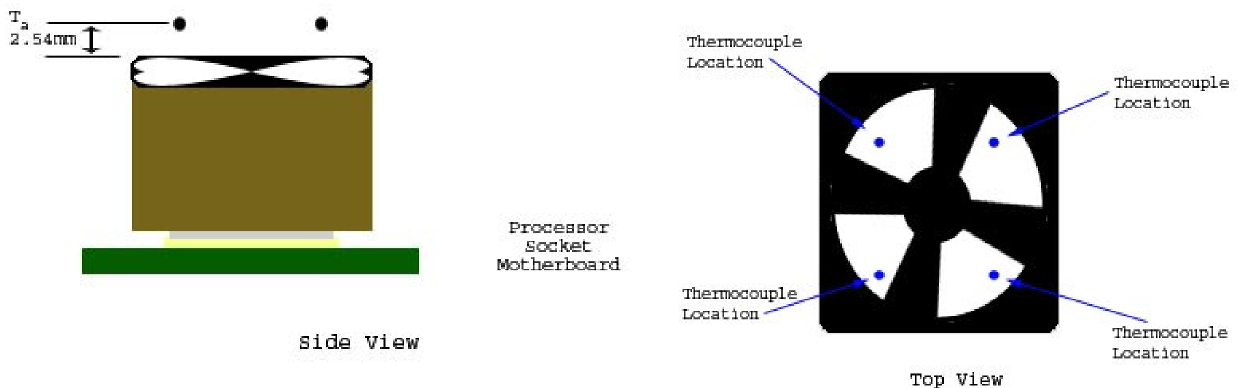
Thermal testing will be performed in a thermal chamber with a controlled ambient temperature of 35ºC. Processor ambient temperature measurement, $T_{a,}$ will be taken at 20 second intervals until thermal equilibrium (steady state) is reached. Steady state is reached when the difference between the current reading and the previous reading is less that 0.5%. Data will be collected for 5 minutes past the time determined to be steady state. The last data point is recorded in the test report with no averaging.

4.4. Thermocouple Calibration Check

It is important to ensure that the thermocouples used for ambient and case temperature measurements are calibrated. A Hot-Point* Calibration Cell is used to check the accuracy of thermocouples prior to any thermocouple being used for testing – each thermocouple is placed in the cell and then set to 0ºC and 100ºC. The thermocouple reading should be within +/-0.5ºC of the set point.

4.5. Thermocouple Placement

To record the processor local ambient air temperature (T_a) measurements, 4 thermocouples are placed equally spaced 2.54mm (0.1") either above or in front of the fan hub (depending on FHS orientation), halfway between the fan hub and housing (See Figure 5-1).



4.7. Test Procedure

The BIOS of the system under test is reset to default settings where appropriate and all power saving features and system management functions are disabled. The system is then booted into the relevant Operating System and test software installed.

The application used for thermal testing is the Intel® Power Thermal Utility (PTU). This is activated to stress the processor to its Thermal Design Point and at no point during the test should the processor activate its thermal control circuit.

The thermocouple temperatures throughout the system are logged by the chamber control software over a period as stated in section 4.3.

CPU core temperatures are monitored using the PTU and maximum DTS value is recorded.

4.8. Additional Monitor Points

Customer defined thermocouple locations

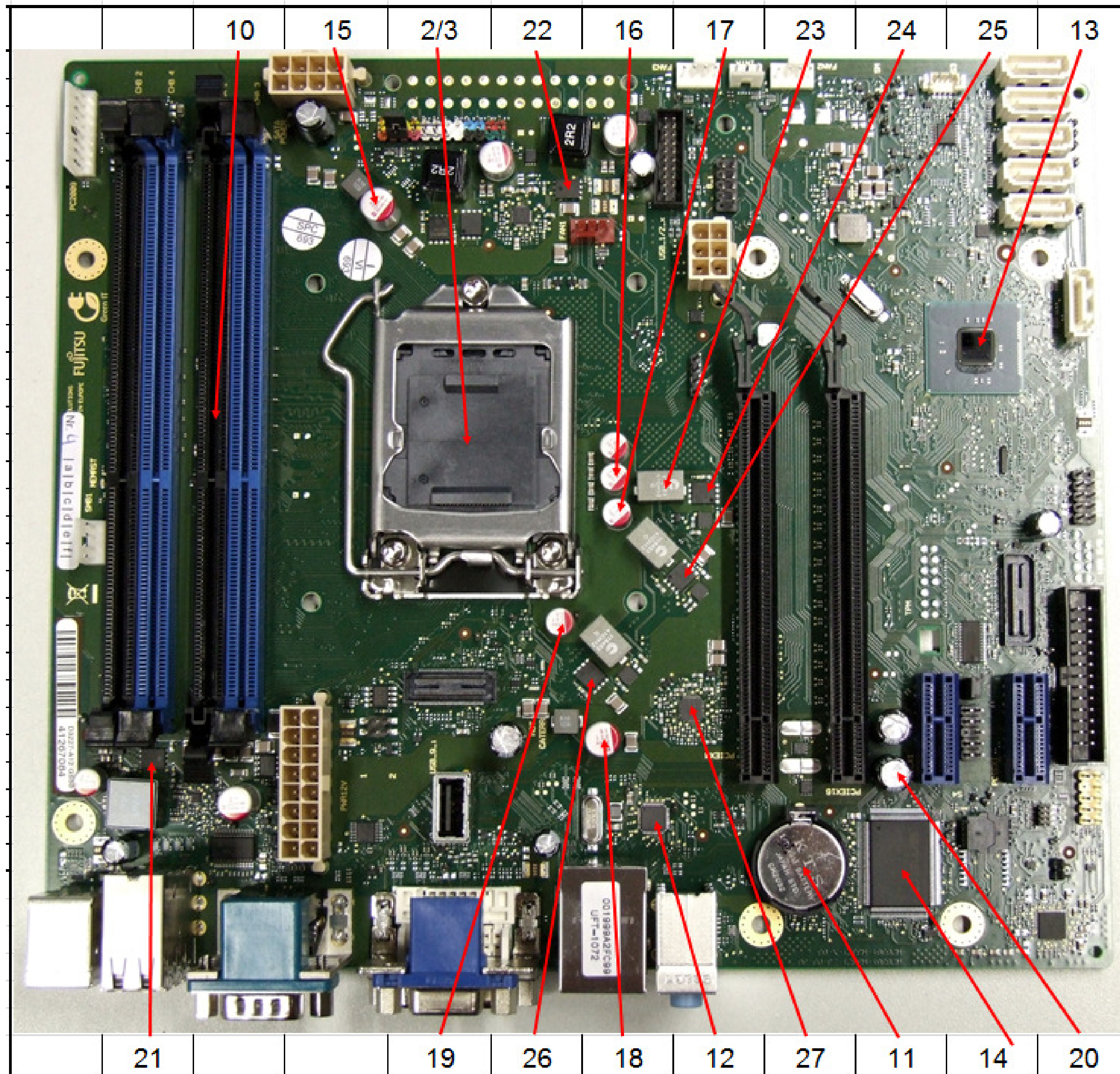


Figure 4-2 Thermocouple locations

5. Thermal Test Results

All pass results are within the accuracy of the test equipment (see section 4.2).

5.1. Test Specifications & Limits

The information in this section is taken from the relevant processor Electrical, Mechanical & Thermal Specification document (EMTS).

5.1.1. **Intel® Core™ i5-4670K Processor** Thermal Specifications

Criteria	**Specification**	**Note**
Processor TCC Activation	100 ºC	DTS temperature
Processor T_A	42 ºC	

5.2. Test Equipment/Test Deviations

System temperatures were recorded at both 35 and 45 degree Celsius external ambient during the following test states:

- System idle
- Intel Power Thermal Utility
- FTS System Test

5.3. Thermal Stress Test Results, 35°C External Ambient

Number	Component Location	Component Type	Idle	FTS System Test	Intel PTU	Max temp
1	External ambient	-	35	35	35	N/A
2	CPU DTS	-	49	73	85	100°
3	CPU ambient	-	35.8	37.8	41.2	N/A
4	N/A					
5	PSU_in	PSU	37.8	40.7	42.2	N/A
6	PSU_out	PSU	38.6	41.5	43.4	55°
7	N/A					
8	N/A					
9	N/A					
10.1	CHA1	DIMM	37.3	43.0	44.5	85°
10.2	CHB1	DIMM	38.1	45.4	45.0	85°
11	CR2032	Battery	37.3	43.6	47.3	60°
12	i217 Clarkville	LAN	37.7	46.4	49.2	85°
13	Q87 (Lynx Point)	PCH	47.3	54.4	51.9	104°
14	SMSC 5627/5636	SIO	38.3	41.6	46.8	70°
15	N/A					
16	VCC_CPUCORE	Capacitor	37.6	50.4	51.8	65°
17	VCC_CPUCORE	Capacitor	37.8	50.1	51.5	65°
18	P12VP_FILTER_CORE	Capacitor	37.5	47.7	49.0	65°
19	VCC_CPUCORE	Capacitor	37.2	47.3	48.4	65°
20	P12VP_V2	Capacitor	37.7	43.1	45.8	65°
21	P1V5P_DDR3	Dual FET	37.0	41.5	45.1	100°
22	N/A					
23	VCC_CPUCORE	Coil	36.7	53.4	55.0	100°
24	VCC_CPUCORE	FET	38.9	55.2	64.6	100°
25	VCC_CPUCORE	FET	39.0	55.8	62.5	100°
26	VCC_CPUCORE	Regulator	36.7	49.5	53.7	90°
27	VCC_CPUCORE	FET	38.9	51.1	52.6	100°

Table 5-1 Thermal Test Results at 35°C External Ambient

5.1. Thermal Stress Test Results, 45°C External Ambient

Number	Component Location	Component Type	Idle	FTS System Test	Intel PTU	Max temp
1	External ambient	-	45	45	45	N/A
2	CPU DTS	-	56	94	80	100°
3	CPU ambient	-	45.8	48.1	50.0	N/A
4	N/A					
5	PSU_in	PSU	46.3	48.7	51.0	N/A
6	PSU_out	PSU	46.7	50.0	52.4	55°
7	N/A					
8	N/A					
9	N/A					
10.1	CHA1	DIMM	46.1	51.7	53.3	85°
10.2	CHB1	DIMM	47.0	54.8	53.7	85°
11	CR2032	Battery	46.4	52.1	56.2	60°
12	i217 Clarkville	LAN	47.6	53.6	57.9	85°
13	Q87 (Lynx Point)	PCH	59.9	59.4	60.1	104°
14	SMSC 5627/5636	SIO	47.0	52.1	55.7	70°
15	N/A					
16	VCC_CPUCORE	Capacitor	47.7	55.3	60.4	65°
17	VCC_CPUCORE	Capacitor	47.6	55.2	60.1	65°
18	P12VP_FILTER_CORE	Capacitor	47.4	53.7	57.5	65°
19	VCC_CPUCORE	Capacitor	47.0	53.1	56.9	65°
20	P12VP_V2	Capacitor	46.8	51.5	54.7	65°
21	P1V5P_DDR3	Dual FET	46.0	50.2	54.2	100°
22	N/A					
23	VCC_CPUCORE	Coil	51.0	57.9	63.7	100°
24	VCC_CPUCORE	FET	52.0	61.7	74.1	100°
25	VCC_CPUCORE	FET	52.3	62.0	71.5	100°
26	VCC_CPUCORE	Regulator	48.4	56.4	62.4	90°
27	VCC_CPUCORE	FET	49.6	57.0	61.4	100°

Table 5-2 Thermal Test Results at 45°C External Ambient

6. Conclusion

The system **PASSES** tests to Intel Thermal Specifications in the configuration detailed in Section 3.3 using the **Intel® Core™ i5-4670K Processor (Q-Spec) (6M Cache, up to 3.80 GHz).**

System temperatures remained within specification at both 35 and 45 degree Celsius external ambient during the following test states:

- System idle
- Intel Power Thermal Utility
- FTS System Test

7. References

7.1. Thermal Support Documentation

Refer to the following documentation for more information.

Relevant Intel Processor Electrical, Mechanical & Thermal Specification (EMTS)
Relevant Intel Processor Thermal Design Guidelines.
Thin Mini-ITX Based PC System Design Guide
ATX, µATX, BTX and µBTX specifications [http://www.formfactors.org]

Table 7-1