Intel® Core™2 Extreme Processor QX9775$^{\Delta}$

Thermal and Mechanical Design Guidelines Addendum

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Revision History

Revision Number	Description	Revision Date
-001	Initial release.	February 2008

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1 Introduction

1.1 Document Goals and Scope

1.1.1 Importance of Thermal Management

The objective of thermal management is to ensure that the temperatures of all components in a system are maintained within their functional temperature range. Within this temperature range, a component is expected to meet its specified performance. Operation outside the functional temperature range can degrade system performance, cause logic errors or cause component and/or system damage. Temperatures exceeding the maximum operating limit of a component may result in irreversible changes in the operating characteristics of this component.

In a system environment, the processor temperature is a function of both system and component thermal characteristics. The system level thermal constraints consist of the local ambient air temperature and airflow over the processor as well as the physical constraints at and above the processor. The processor temperature depends in particular on the component power dissipation, the processor package thermal characteristics, and the processor thermal solution.

All of these parameters are affected by the continued push of technology to increase processor performance levels and packaging density (more transistors). As operating frequencies increase and packaging size decreases, the power density increases while the thermal solution space and airflow typically become more constrained or remains the same within the system. The result is an increased importance on system design to ensure that thermal design requirements are met for each component, including the processor, in the system.

1.1.2 Document Goals

Depending on the type of system and the chassis characteristics, new system and component designs may be required to provide adequate cooling for the processor. The goal of this document is to provide an understanding of these thermal characteristics and discuss guidelines for meeting the thermal requirements imposed on single processor systems (or dual processors systems) using the Intel® Core™2 Extreme Processor QX9775.

1.1.3 Document Scope

This document is an addendum to support the following processor:

- Intel® Core™2 Extreme processor QX9775

In this document when a reference is made to "the processor" it is intended that this includes all the processors supported by this document. If needed for clarity, the specific processor will be listed.

In this document, when a reference is made to "the datasheet", the reader should refer to the *Intel® Core™2 Extreme Processor QX9775 Datasheet*. If needed for clarity the specific processor datasheet will be referenced.

This document is an addendum to the *Intel® Core™2 Extreme Processor and Intel® Core™2 Quad Processor Thermal and Mechanical Design Guidelines* and *Intel® Core™2 Extreme Processor QX6800 Thermal and Mechanical Design Guidelines.* In this document, when a reference is made to "the TMDG", the reader should refer to the both TMDGs (see Section 1.2).

This addendum only covers the parameters that are unique designing a thermal solution for a system using the processor. The reader must refer to both this addendum and the referenced TMDG for the details on processor thermal and mechanical design.

Chapter 2 provides the mechanical requirements, the thermal profile and the recommended MAR workload percentage for the processor heatsink thermal and mechanical design.

The physical dimensions and thermal specifications of the processor that are used in this document are for illustration only. Refer to the datasheet for the product dimensions, thermal power dissipation and maximum case temperature. In case of conflict, the data in the datasheet supersedes any data in this document.

1.2 References

Material and concepts available in the following documents may be beneficial when reading this document.

Document	Location
Intel® Core™2 Extreme Processor QX9775 Datasheet	http://www.intel.com/design/processor/datashts/319128.htm
Intel® Core™2 Extreme Processor and Intel® Core™2 Quad Processor Thermal and Mechanical Design Guidelines	http://www.intel.com/design/processor/designex/315594.htm
Intel® Core™2 Extreme Processor QX6800 Thermal and Mechanical Design Guidelines	http://www.intel.com/design/processor/designex/316854.htm
LGA771 Socket Mechanical Design Guide	http://www.intel.com/design/xeon/guides/313871.htm

1.3 Definition of Terms

Term	Description
T_A	The measured ambient temperature locally surrounding the processor. The ambient temperature should be measured just upstream of a passive heatsink or at the fan inlet for an active heatsink.
T_C	The case temperature of the processor, measured at the geometric center of the topside of the IHS.
T_S	Heatsink temperature measured on the underside of the heatsink base, at a location corresponding to T_C.
$T_{C\text{-}MAX}$	The maximum case temperature as specified in a component specification.
Ψ_{CA}	Case-to-ambient thermal characterization parameter (psi). A measure of thermal solution performance using total package power. Defined as (T_C – T_A) / Total Package Power. **Note:** Heat source must be specified for Ψ measurements.
Ψ_{CS}	Case-to-sink thermal characterization parameter. A measure of thermal interface material performance using total package power. Defined as (T_C – T_S) / Total Package Power. **Note:** Heat source must be specified for Ψ measurements.
Ψ_{SA}	Sink-to-ambient thermal characterization parameter. A measure of heatsink thermal performance using total package power. Defined as (T_S – T_A) / Total Package Power. **Note:** Heat source must be specified for Ψ measurements.
P_{MAX}	The maximum power dissipated by a semiconductor component.
TDP	Thermal Design Power: a power dissipation target based on worst-case applications. Thermal solutions should be designed to dissipate the thermal design power.
IHS	Integrated Heat Spreader: a thermally conductive lid integrated into a processor package to improve heat transfer to a thermal solution through heat spreading.
LGA771 Socket	The surface mount socket designed to accept the processors in the 771–Land LGA package.
LGA775 Socket	The surface mount socket designed to accept the processors in the 775–Land LGA package.

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2 Thermal/Mechanical Design

This Chapter described the thermal/mechanical design for the processor. The processor is a HEDT (High End Desktop) processor for PC enthusiast gaming, game developers and professional media creator.

2.1 Mechanical Requirements

2.1.1 Processor Package

The processor is packaged in a 771-Land LGA package that interfaces with the motherboard via a LGA771 socket. Refer to the datasheet for detailed mechanical specifications.

The processor connects to the motherboard through a land grid array (LGA) surface mount socket. The socket contains 771 contacts arrayed about a cavity in the center of the socket with solder balls for surface mounting to the motherboard. The socket is named LGA771 socket. A description of the socket can be found in the *LGA771 Socket Mechanical Design Guide.*

The package includes an integrated heat spreader (IHS). The IHS transfers the non-uniform heat from the die to the top of the IHS, out of which the heat flux is more uniform and spreads over a larger surface area (not the entire IHS area). This allows more efficient heat transfer out of the package to an attached cooling device. The IHS is designed to the interface for contacting a heatsink. Detailed can be found in the datasheet.

2.1.2 Heatsink Size

The size of the heatsink is dictated by height restrictions for installation in a system and by the real estate available on the motherboard and other considerations for component height and placement in the area potentially impacted by the processor heatsink. The height of the heatsink must comply with the requirements and recommendations for customer-design chassis.

The processor socket designs with the LGA775 socket ATX motherboard keep-out restrictions (72 mm x 72mm mounting hole span for ATX). Refer to the TMDG for the detailed motherboard keep-out information.

2.1.3 Heatsink Clip Load Requirement

The attach mechanism for the heatsink developed to support the processor should create a static preload on the package between **18 lbf** and **70 lbf** throughout the life of the product. Refer to the TMDG for the clip load metrology guidelines.

2.2 Thermal Profile

The Thermal Profile defines the maximum case temperature as a function of processor power dissipation. Refer to the datasheet for the further information. Table 1 shows the thermal specification for the thermal design power (TDP) segment.

Table 1. Thermal Specifications

Processor	TDP (W)	$T_{C\text{-}MAX}$ (°C)	Notes
Intel® Core™2 Extreme Processor QX9775	150	63.0	1,2,3,4

NOTES:

1. Thermal Design Power (TDP) should be used for processor thermal solution design targets. The TDP is not the maximum power that the processor can dissipate.
2. T_C and TDP values provided in this table are for reference only. Please contact your Intel field representative for any updates that could occur in the processor datasheet prior to the next revision of this document.
3. Intel® Core™2 Extreme Processor QX9775 Thermal Profile: Y = 0.187 × Watts + 35.0

2.3 System Thermal Solution Considerations

The heat generated by components within the chassis must be removed to provide an adequate operating environment for both the processor and other system components. Moving air through the chassis brings in air from the external ambient environment and transports the heat generated by the processor and other system components out of the system. The number, size and relative position of fans and vents determine the chassis thermal performance, and the resulting ambient temperature around the processor. The size and type of the thermal solution (air cooling or liquid cooling design) and the amount of system airflow can be traded off against each other to meet specific system design constraints.

2.3.1 Heatsink Performance

Table 2 provides the heatsink performance for the processor with the thermal boundary conditions, which assumes that chassis delivers a maximum T_A at the inlet of the processor fan heatsink. Please refer to the TMDG for the local ambient temperature measurement guidelines.

Note: Table 2 shows the T_A assumption is lower than the expected temperature rise in the chassis at 35 °C ambient temperature external to the chassis for the reference thermal solutions and Intel® Boxed thermal solutions published in the TMDG. Refer to the TMDG for the T_A requirements for the reference thermal solutions and Intel® Boxed thermal solutions.

Table 2. Heatsink Performance for the processor in ATX Solutions at T_A = 33.6 °C

Processor	Thermal Performance Ψca (Mean + 3σ)	T_A Assumption
Intel® Core™2 Extreme Processor QX9775	0.196 °C/W	33.6 °C

NOTES:

1. Performance targets (Ψ ca) as measured with a live processor at TDP.
2. Ψca is defined by the equation, Ψca = (T_C – T_A) /TDP. Refer to the TMDG for the thermal metrology on measuring power dissipation and temperature to validate a thermal solution.
3. The local ambient temperature T_A at the heatsink, which is a function of chassis design.

2.3.2 Validation of System Thermal Solution

The system functional validation needs to account for the entire operating environment of the system with the processor thermal solutions /system fans. In addition, the fan speeds control implementation must be verified and it is assumed the system integrator has already validated the thermal solution meets the thermal profile using the TTV.

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