Thermally Advantaged Chassis (TAC)

Design Guide

February 2008

Revision 2.0

Contents

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Revision History

Revision Number	Description	Revision Date
1.0	Initial release. Chassis Air Guide (CAG) Design Guide	May 2002
1.1	System vent pattern optimization. Chassis Air Guide (CAG) Design Guide	September 2003
2.0	Re-design to accommodate 2009 platforms. Document title renamed to Thermally Advantaged Chassis (TAC) 2.0 to reflect the elimination of the CAG side duct.	February 2008

1 Introduction

1.1 Scope

This design guide explores the design and performance of a generic airflow management scheme to adequately cool the internal components of a personal computer. Design recommendations are presented for implementation within mid-tower and mini-tower desktop style enclosures. The target audiences for this document are: computer enclosure engineers, designers, and system integrators.

1.2 Overview

In order to facilitate next generation PC platform designs for 2009 and beyond, it has become necessary to alter the physical location of the processor relative to previous platform generations. Earlier versions of the Chassis Air Guide (CAG) Design Guide presented a reference airflow management scheme that was dependant on a relatively consistent location of the processor. The TAC 2.0 design guide accommodates this change in processor location and provides backward compatibility to previous PC platform generations.

Improvements in processor architecture design and reductions in transistor leakage have resulted in more efficient processors that consume less power with better performance than earlier generations. The goal of previous CAG Design Guide versions was to define a means to limit the processor inlet temperature to a maximum of 38 °C to allow for the use of cost effective processor cooling devices. With the improvements in latest generation processor designs and performance it is possible to design cost effective processor cooling solutions with a higher inlet temperature. Therefore, In addition to eliminating processor location dependency, the TAC 2.0 Design Guide also defines a new processor cooling solution inlet temperature target of 40 °C.

The scope of the previous CAG Design Guide was centered on an enclosure side duct that delivered cooler external air directly to the processor fan heatsink. This revised design guide eliminates the duct and relies solely on optimized chassis venting and airflow management. This not only eliminates the above mentioned processor location dependency but also allows for PC enclosure cost reduction when compared to previous CAG Design Guide versions.

Proper thermal management of PC enclosure design is critical to the performance and functionality of internal PC components as well as achieving desirable acoustic noise levels. There are many different ways to provide proper chassis thermal management. The design approach described in the document is one such method that if implemented correctly will provide a single, cost effective solution for a wide range of PC platform generations.

1.3 Recommended Chassis Type

This design guide refers to a chassis with the features listed below. However, the ingredients and design techniques described here could be adapted to other chassis:

- Fits a standard ATX or µATX motherboard
- Supports two external 5.25-inch peripheral bays, one or two external 3.5-inch peripheral bays, and one or two internal 3.5-inch peripheral bays
- Includes standard support for add-in cards
- Provides single system-fan cooling with provision for at least one 92mm rear exhaust fan
    - (Note that this statement excludes the fan in the Power Supply)
- Internal power supply with fan exhausting from the system enclosure

1.4 Reference Documents

Document / Resource	Document Location
ISO 7779-Acoustics–Measurement of Airborne Noise Emitted by information Technology and Telecommunications Equipment	http://www.iso.org
General system and component design guides and suggestions	http://www.formfactors.org/

2 Section 2

2.1 Thermally Advantaged Chassis Description

The following design is intended to provide a desirable internal thermal environment for standard ATX and µATX tower style chassis. One key goal is to achieve a temperature rise from external ambient to the processor fan heatsink (T_{rise}) of 5 °C or less (or 40°C inlet to the fan heatsink at the typical maximum external ambient temperature of 35°C). Details on thermocouple placement for CPU fan heatsink inlet temperature measurement can be found in applicable Thermal Design Guide (TDG) documents. This design does not require any special ducting or other components typically not found in PC enclosure designs and relies entirely on vent size/placement and proper air flow.

Figure 1 represents a generic µATX tower chassis similar to that used in many platforms currently available. The single side vent shown has been optimized in size, location, and effective open area to provide desirable internal temperature conditions at external operating temperatures of 35 °C or less. The vent relies entirely on typical internal system fans (one rear chassis exhaust fan, one power supply exhaust fan, and one active CPU heatsink fan) to distribute air throughout the system components. There is no requirement for a side panel intake fan with this design approach. Detailed size and location dimensions for the side vent are shown in Section 5.

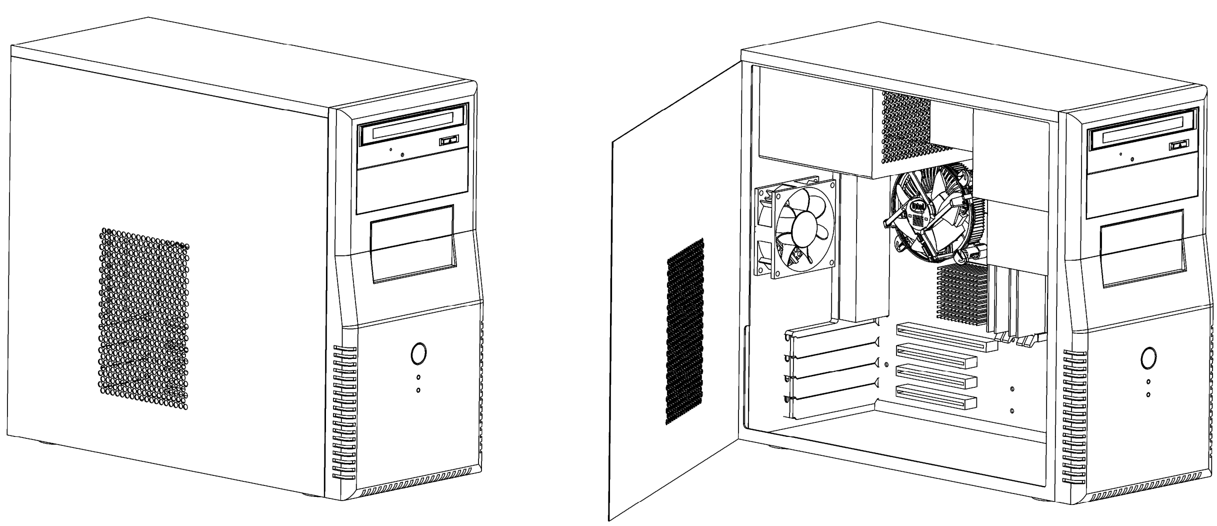

Figure 1. Typical Tower Platform With Optimized Side Vent

2.2 Thermally Advantaged Chassis Typical Airflow Pattern

Figure 2 depicts the intended airflow pattern with the side vent. This system has a 92mm rear system fan and 80mm power supply fan. Both fans exhaust (blow out) from the chassis, thereby providing intake airflow for internal system component cooling. This fan configuration causes depressurization of the chassis interior with respect to the outside air. As a result, all other chassis openings become intake vents. The primary intake vent defined in this design guide is the side panel vent however other smaller vent locations such as the front bezel and add-in card areas can be beneficial as well.

Airflow balancing is critical to ensure the adequate cooling of all system components. Without proper balancing, some components may operate cooler than required while others may operate in a higher temperature environment. Proper airflow balancing is difficult to manage but done properly, should allow all system components to operate within the recommended temperature range. Ensuring balanced airflow is the responsibility of the chassis designer.

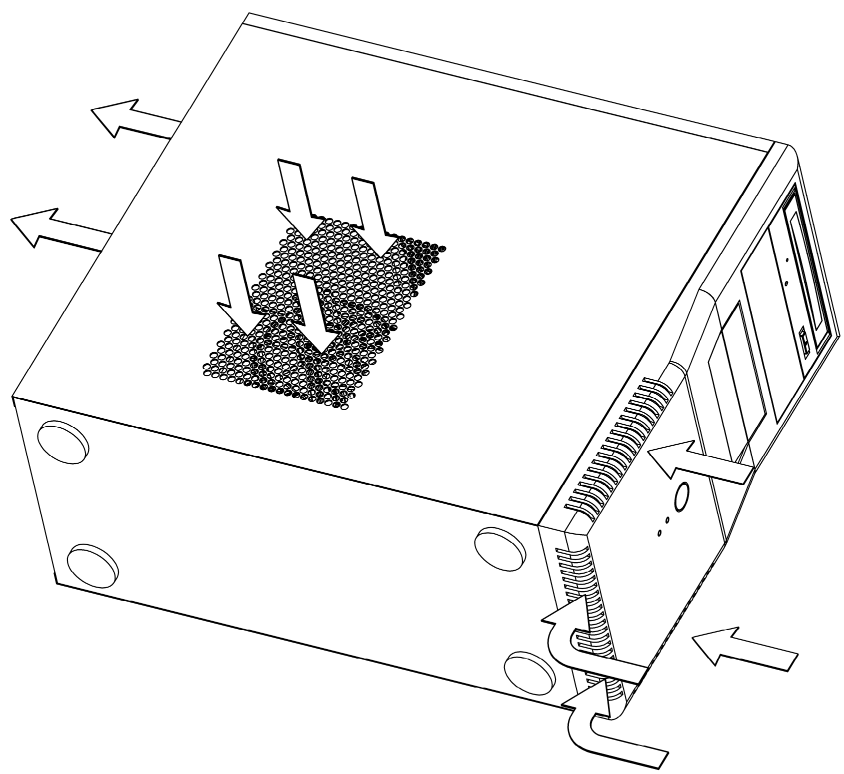

Figure 2. Thermally Advantaged Chassis Typical Airflow Pattern

2.3 System Fans

Rear Chassis System Exhaust Fan:

The chassis mounted system fan remains a critical part of the overall system solution. The rear exhausting system fan contributes to the intended low internal pressure that forces cooler external air to flow into the system vent(s). A 92mm rear fan is recommended however there are many options that will perform adequately. It is critical to design the vent opening for the rear chassis fan to minimize back pressure so that it does not overly restrict the exhaust air flow. The chassis designer is responsible for selecting the appropriate rear exhaust fan and corresponding vent design for a given application.

Power Supply Fan:

The power supply fans seen in the market today in general have shown to be adequate to support the overall system air flow design intent defined in this document. The power supply fan must exhaust the internal chassis air outside of the system to assist with internal cooling. A power supply fan that pressurizes the chassis could render the TAC 2.0 vent configuration ineffective. No changes or special considerations beyond air flow direction are intended for power supplies in this design guide.

Note: Some enclosure designs may utilize system pressurizing via intake fans for thermal management. This is a design choice that is not intended or recommended in the scope of the TAC 2.0 Design Guide.

Processor Active Fan Heat Sink:

Much the same as the rear system and power supply exhaust fans, the processor cooling fan remains a critical piece of the overall system cooling solution. An active CPU fan heatsink with airflow directed towards the main board is assumed in the TAC 2.0 Design Guide and is needed to properly cool the processor and surrounding components.

Optimized chassis airflow will directly minimize the performance requirements (and cost) of internal heat dissipation devices such as processor fan heatsinks.

2.4 TAC 2.0 Vent Size and Location

The TAC 2.0 Design Guide requires a side vent as seen in Figure 1. This vent configuration has been optimized by means of thermal modeling and system level testing. The size of this vent is recommended to be 110mm wide and 150mm tall. The TAC 2.0 side vent is best located with respect to the standard ATX mounting holes as defined in the ATX Specification. Refer to Section 5 for detailed vent size and location dimensions.

It is recommended that this vent have an effective open area of at least 60%. This will maximize the effectiveness of the vent and should still contain EMI effectively. Lower open area percentages may also be effective however this is a design choice and understanding the performance implications for a given chassis is the responsibility of the chassis designer. Proper EMI containment is also the responsibility of the chassis manufacturer.

Venting in the front of the chassis behind the bezel is an important component of overall system airflow. However, due to wide ranging variations in bezel configurations, front vent design details must be left to the chassis designer.

The chassis designer may want to provide features on the chassis side panel to mitigate vent blocking if the system should be placed against a wall, desk or other obstruction.

3 Dynamics

While this design guide requires no additional discrete chassis components it is recommended that the chassis be able to withstand the dynamic stress conditions listed below without displaced or damaged components.

3.1 Shock Test

Unpackaged

25 g, 11 ms trapezoidal; ~ 170 in/s

Two drops in each of the six directions applied to each of the test samples

3.2 Vibration Test

Unpackaged

Sine sweep: 5 Hz to 500 Hz @ 0.5 g ±10%; @ 0.5 octaves/min; Dwell 15 min at each of three resonant points

Random Profile: 5 Hz @ 0.01 g^2 /Hz to 20 Hz @0.02 g^2/Hz (slope up)

20 Hz to 500 Hz @ 0.02 g^2/Hz (flat)

Input acceleration: 3.13 g RMS

10 min/axis for all axes on all samples

Random control limit tolerance is ±3 dB

3.3 Pass Criteria

- No visible or functional damage.
- No displaced or dislodged components.

4 Regulatory Considerations

The PC must meet a number of regulatory Safety, EMC and Ecology concerns. Specific requirements for Information Technology Equipment vary somewhat by country, however, the overall standards are somewhat unified and are based upon the following standards: Note: Certain countries may require formal certifications and many require a Declaration of Conformance (DOC) be placed in the manual or on the box. In Europe the CE mark and a DOC is required for every computing device.

4.1 Electromagnetic Interference Radiation

The Electromagnetic Interference (EMI) performance of a system is determined by the degree of noise suppression designed into the system motherboard and the provisions for EMI containment in the chassis design, including placement of internal subsystems and cables. Requirements call for compliance to stringent electromagnetic compatibility (EMC) limits such as the CISPR-22 European standard or the FCC "B" United States standard. Open chassis requirements for board manufacturers suggest that most EMI needs to be suppressed at the board level. The chassis, however, should provide at least 6 dB of EMI attenuation or Shielding Effectiveness (SE) throughout the spectrum. The goal of 6 dB assumes the board complies with FCC Part 15 (Open Box Test). Boards that have higher expected emissions will likely require additional containment. These standards, along with higher processor and video frequencies, call for additional chassis containment provisions. Basic design principles have not changed, but as frequencies increase, the shorter wavelengths require more frequent ground contacts and smaller apertures in the chassis design.

EMC Standards:

- 47 CFR Parts 2 and 15 (USA)
- ICES-003 (Canada)
- EN55022:1998 (European Union Emissions)
- EN55024:1998 (European Union Immunity)
- Other International requirements based upon CISPR 22

4.2 Safety

This design guide is not intended to cover all safety aspects that may pertain to different countries and regulatory bodies. The safety standards listed below are a starting point for reference however, the manufacturer is ultimately responsible to ensure that all applicable safety standards are adhered to.

Safety Standards:

- IEC 60590 (International)
- UL/CSA 60950 (USA and Canada)
- EN60590 (European Union)

4.3 Ecology

This design guide is not intended to cover every aspect of designing a product to meet every International regulation, however, the following standards and programs may cover Ecology issues that may or may not apply to your product.

Ecological Standards

- ECMA TR70:
- Energy Star
- TCO '99, Blue Angel
- RoHS

Ecological Programs

- Participation in waste electronics recycling program.
- Participation in a packaging-recycling program.

5 Mechanical Drawings

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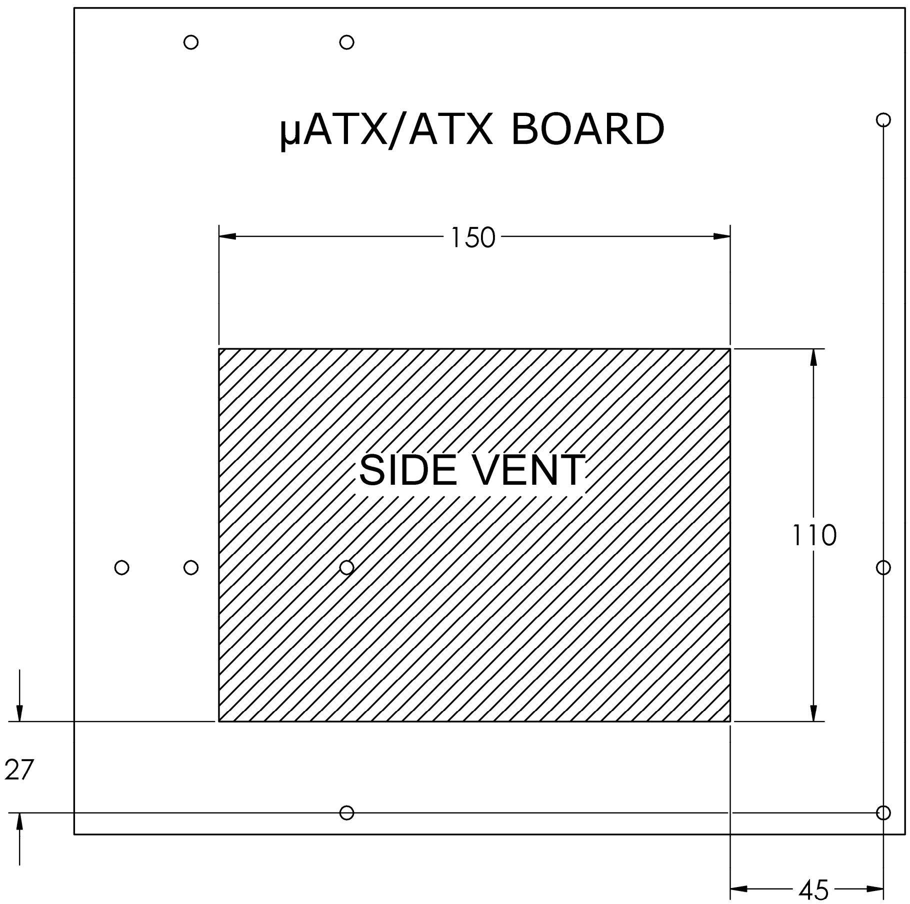
REVISION HISTORY				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	1	INITIAL RELEASE	02/2008	



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DIMENSIONS ARE IN MILIMETERS.
TOLERANCES:

ZERO DECIMAL PLACE: ± 1mm

INTERPRET DIM AND TOL PER ASME Y14.5M-1994.

MATERIAL:

FINISH:

DESIGNED BY | DATE

DRAWN BY | DATE

CHECKED BY | DATE

APPROVED BY | DATE

THIRD ANGLE PROJECTION

DEPARTMENT: CPG

intel — 1900 PRAIRIE CITY ROAD, FOLSOM, CA 95630

TITLE

TAC 2.0 SIDE VENT

SIZE: C | CAGE CODE | DRAWING NUMBER: **E35223** | REV: **1**

SCALE: 1:2 | DO NOT SCALE DRAWING | SHEET 1 OF 1

DWG. NO. | SH. 1 | REV.

REVISION HISTORY

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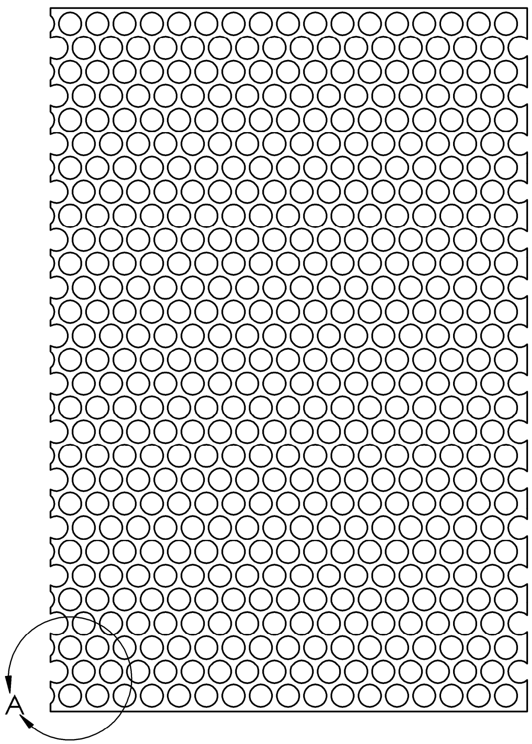

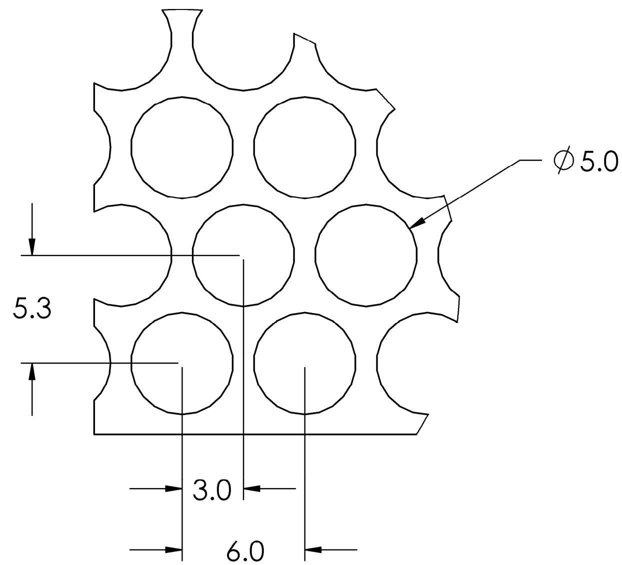

DETAIL A
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UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILIMETERS.
TOLERANCES:

ZERO DECIMAL PLACE: ± 0.2mm

INTERPRET DIM AND TOL PER
ASME Y14.5M-1994.

MATERIAL:

FINISH:

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THIRD ANGLE PROJECTION

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TITLE

TAC 2.0 SIDE VENT 60% OPEN AREA DETAIL

SIZE	CAGE CODE	DRAWING NUMBER	REV
C		E35224	1

SCALE: 1:2 | DO NOT SCALE DRAWING | SHEET 1 OF 1

DWG. NO. | SH. 1 | REV.