WTX
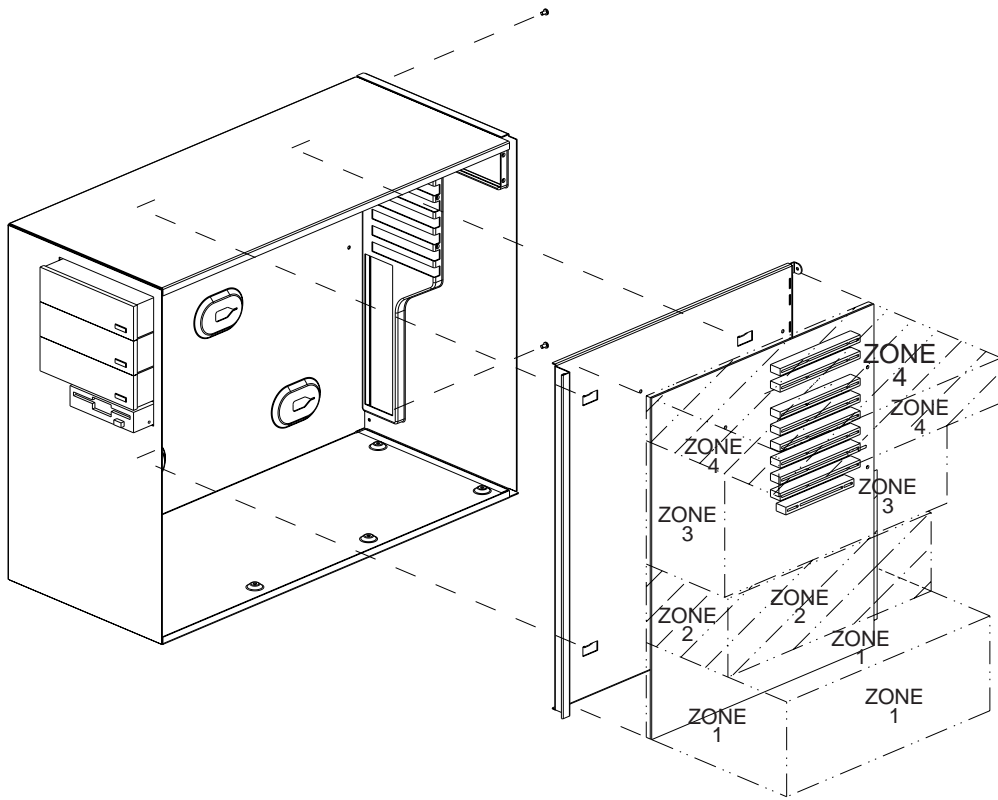
Workstation System Specification

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Preface

What is WTX?

WTX is a new board-set and system form factor developed for the mid-range workstation market segment. This specification defines the board-set volume, interface between the board-set and chassis, and required chassis features. The specification also provides design suggestions for thermal management and electromagnetic interference and containment. This specification is provided for widespread use in the design of many types of systems.

What This Document Contains

If you want to know…	Refer to…
Executive Summary	Chapter 1
General information about WTX	Chapter 2
Detailed information about WTX mechanical specifications	Chapter 3
Detailed information about thermal management of WTX	Chapter 4
Detailed information about EMI containment of WTX	Chapter 5
Detailed information about the power supply requirements of WTX	Chapter 6

Dimensions and Tolerances

All dimensions are given as inches [millimeters] unless otherwise specified. Tolerances are given in the following table.

Default tolerances

X.XXX inches	+/- 0.010 inches [0,25]
X.XX inches	+/- 0.025 inches [0,64]
X.X inches	+/- 0.100 inches [2,54]

It is expected that the majority of WTX systems will be in a vertical (tower) orientation. Therefore, drawings are presented with components in a vertical orientation unless otherwise specified.

Revision Summary

Revision	Revision History	Date
-001	First Release of the WTX Workstation System Specification	September 1998
1.1	• Section 2.5 – changed "Flex Slot provides a removable, customizable I/O card for WTX systems, and offers the following advantages" to "Flex Slot can provide a removable, customizable I/O card for WTX systems, offering the following advantages" • Figure 3 – changed reference Flex Slot I/O card centerline from .837 to 1.239 and added text; corrected rear I/O window to match chassis; corrected AGP-Pro Pin-1 location • Figure 6 – changed Zone 2 height dimension 4.800 to 4.900; added two .100 board retention keep-out areas • Figure 8 – changed Detail A slot dimensions .489 to .519, 2.449 to 2.499, .319 to .368; added view Section C-C with piercing height detail and dimension • Figure 9 – changed Section B-B dimension .439 to .487; changed Bottom View dimensions .587 to .539, .343 to .391, .593 to .641 (2 places); changed Rear View dimension .343 to .391 • Figure 11 – changed end view dimension .675 to .550 • Figure 12 – redimensioned slot locations to front of slots, changed dimension 3.451 to 2.401, 8.326 to 7.276, 13.201 to 12.151; redimensioned Detail A to front of slot, changed .45 to .600, combined 1.050 and .30 to 1.350, changed .070 to .090, added dimension .3 • Figure 13 – changed side view dimensions .583 to .593, 1.250 to 1.000, 1.112 to 1.124; changed front view dimensions .197 to .212, .368 to .391, .130 to .156, .106 to .118, .864 to .877, 2.609 to 2.622; changed end view dimensions 4.230 to 4.247, 8.331 to 8.349 • Figure 14 – changed dimensions .070 to 1.190, 14.250 to 13.010, 7.656 to 7.600; changed Section A-A dimension 13.949 to 13.959 • Figure 15 – changed front view dimensions 8.904 to 8.821, 8.483 to 8.5, 8.133 to 8.146, 1.284 to 1.322, .486 to .522; changed side view dimensions .600 to .556, .400 to .430, 1.250 to 1.000, .169 to .202, 1.325 to 1.556 • Figure 16 – redimensioned front view vertical dimensions to top of flange, deleted dimension .133, changed 3.985 to 4.118, 8.045 to 8.180, 1.742 to 1.724, .143 to .151, .276 to .258, .475 to .500; changed top view dimensions .050 to .046, .389 to .639, 1.250 to 1.000, .136 to .156 • Section 6.1 – changed "…to integrate power supplies suited to…." to "…to develop power supply delivery solutions suited to…."; changed "800W" to "850W" • Figure 18 – revised and redrawn • Figure 19 – revised and redrawn • Section 6.2.1 – changed "…provides the base DC power	February 1999

requirements and control signals and is intended to be positioned near the 22-pin connector described in Section 6.2.2" to "…provides the 3.3V and 5V (including standby and auxiliary) voltages to the board set(s) of WTX compliant systems"

- Section 6.2.2 – changed "…provides 12V DC power to DC-DC converters or VRMs (voltage regulator modules) used to power microprocessor cartridges or large memory configurations. (xxx = Dig, CPU, or CPU2)" to "…provides the 3.3V and 5V (including standby and auxiliary) voltages to the board set(s) of WTX compliant systems"; changed pins "1394" and "1394rtn" to "reserved"

- Section 6.2.3 – Changed title from "12V VRM Power Connector" to "$12V_{DIG}$ VRM/D2D Output Power Connector"; changed "…provides 12V DC power to DC-DC converters or VRMs (voltage regulator modules) used to power microprocessor cartridges or large memory configurations. (xxx = Dig, CPU, or CPU2." to "…provides 12V DC power to D2Ds (DC-DC converters) and/or VRMs (Voltage regulator modules) used to power microprocessor or large memory configurations"; changed "$12V_{XXX}$" to "$12V_{DIG}$" (3 places); changed "res." (2 places) to "$12V_{DIG\ SENSE}$" and "$12V_{DIG\ RTN}$"

- Section 6.2.4 – added this section

- Table 4 – changed definition of "Sleep" from "…5VSB, 3.3VSB, and 12VDIG…" to "…$5V_{SB}$, $3.3V_{AUX}$, and $12V_{DIG}$…"; added term and definition for "I2C data"; changed term "Xvsense" to "xVsense"; changed term "Xvsense rtn" to "xVsense rtn"; removed term and definition for "1394" and "1394rtn"; added term and definition for "Reserved"

Contents

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1 Executive Summary

WTX is a new board-set and system form factor developed for the mid-range workstation market segment. This specification defines the board-set volume, interface between the board-set and chassis, and required chassis features. The specification also provides design suggestions for thermal management and electromagnetic interference and containment.

Several manufacturers of Intel® architecture based workstations collaborated to define the WTX form factor and to incorporate flexibility to accommodate the best designs for current and future mid-range workstations.

The WTX specification is provided for widespread use in many types of systems. The specification and other information on WTX are available through the following web site: http://www.wtx.org

1.1 WTX Features

The WTX form factor is designed to support:

- Current and future Intel®-based 32- and 64-bit processor technologies
- Dual processor motherboards in all configurations
- Current and future memory technologies
- Current and future graphics technologies
- Flex Slot I/O cards for simplified motherboard partitioning and OEM differentiation
- Workstation end-user requirements (deskside form factor, accessibility to memory and expansion slots, and rack mount capability)
- Increased system level design and integration flexibility

1.2 Other Technical Resources

For additional information, the following WTX resources will be available through the following public web site: http://www.wtx.org

Title	Description
WTX Power Supply Guide	Power supply description including voltage and current tolerances and signal definitions.
WTX System Design Guide	Detailed example WTX-compliant chassis with design suggestions and recommendations.
WTX Board and System Gauges	Block and shell gauges inserted into chassis or over boards to help verify WTX compliance.

2 Overview

2.1 Goals

There are several specific goals for the WTX form factor:

- Facilitate time to market of technology transitions
- Decrease development and system cost
- Design for differentiation

2.1.1 Facilitate Time to Market of Technology Transitions

WTX is designed for growth. It will facilitate an efficient and cost effective transition to future processor, graphics, and memory technologies. This is accomplished by using a single chassis across multiple market segment tiers and over multiple generations.

2.1.2 Decrease Development and System Cost

WTX is expected to decrease both development and product costs. Designing a single chassis that can be used over multiple product lines provides flexibility and improved time to market. Standardizing a mid-range workstation form factor will create larger volumes for key components, such as power supplies and chassis.

2.1.3 Design for Differentiation

The WTX form factor must be specific enough to achieve the first two goals, yet flexible enough to enable OEMs significant room for differentiation and added value. For example, the board-set volume must allow any WTX compliant board-set to mount in any WTX compliant chassis, yet still enable OEMs or chassis manufacturers to add value in the chassis (industrial design, expansion bays, additional I/O, security, etc.). Additionally, the WTX form factor includes a Flex Slot architecture that allows, but does not require, board-sets to be developed with a modular I/O architecture. This architecture provides OEMs with flexibility in motherboard design and the ability to re-use Flex Slot boards from one generation to the next.

2.2 Benefits to End Users

The mid-range workstation market segment is very different from the PC or basic business desktop market segments. Workstation users have different hardware needs that vary according to the application set they use. For example:

- A digital content creation user may require a mid-range workstation that is designed to accommodate dual processing (for faster rendering), larger memory capacity (for higher frame rate buffers), significant PCI and AGP expansion capability (for audio and video capture), and a power supply capable of supporting these components.
- A mechanical computer aided design field user will have hardware needs focused on dual processing, memory, and graphics.

- An electronic design automation field user may be more concerned with a workstation that runs faster simulations with little emphasis on graphics and will chose a workstation with dual processing, extensive memory expansion, and the ability to rack mount.

Current industry desktop standards do not have the system capacity to address these needs. WTX introduces Intel architecture into these developing high-end market segments.

2.3 WTX Implementation

In order to introduce common components into the developing workstation market segment without compromising innovation or differentiation, WTX introduces the following new components:

- Board adapter plate
- Flex Slot

2.3.1 Board Adapter Plate

The board adapter plate enables designers to connect any compatible motherboard to a WTX chassis without mounting hole restrictions. Mounting of the motherboard to the adapter plate is left to the discretion of the board designer. This supports maximum board design flexibility, while maintaining chassis-to-chassis compatibility. The interfaces between this plate and the chassis are described in Section 3.3 and Section 3.4.

2.3.2 Flex Slot

The Flex Slot volume and its corresponding rear panel opening enables innovation at the board-set level while preserving motherboard/chassis interchangeability. Refer to Section 3.5 for additional information about Flex Slot.

2.4 Example System Configuration

Figure 1 illustrates one possible configuration of a WTX-compliant system, shown closed and open for service. The exterior skins are removed for visibility, and many components have been simplified. This example shows the power supply overhanging the motherboard to illustrate a tower model that might also serve as rack-mountable. When opened for service, the power supply is rotated along the rear edge to access the motherboard, and the external drives are moved forward to permit travel of the board-set.

Detailed information on this implementation is available in the *WTX System Design Guide*.

SYSTEM CLOSED

SYSTEM OPEN
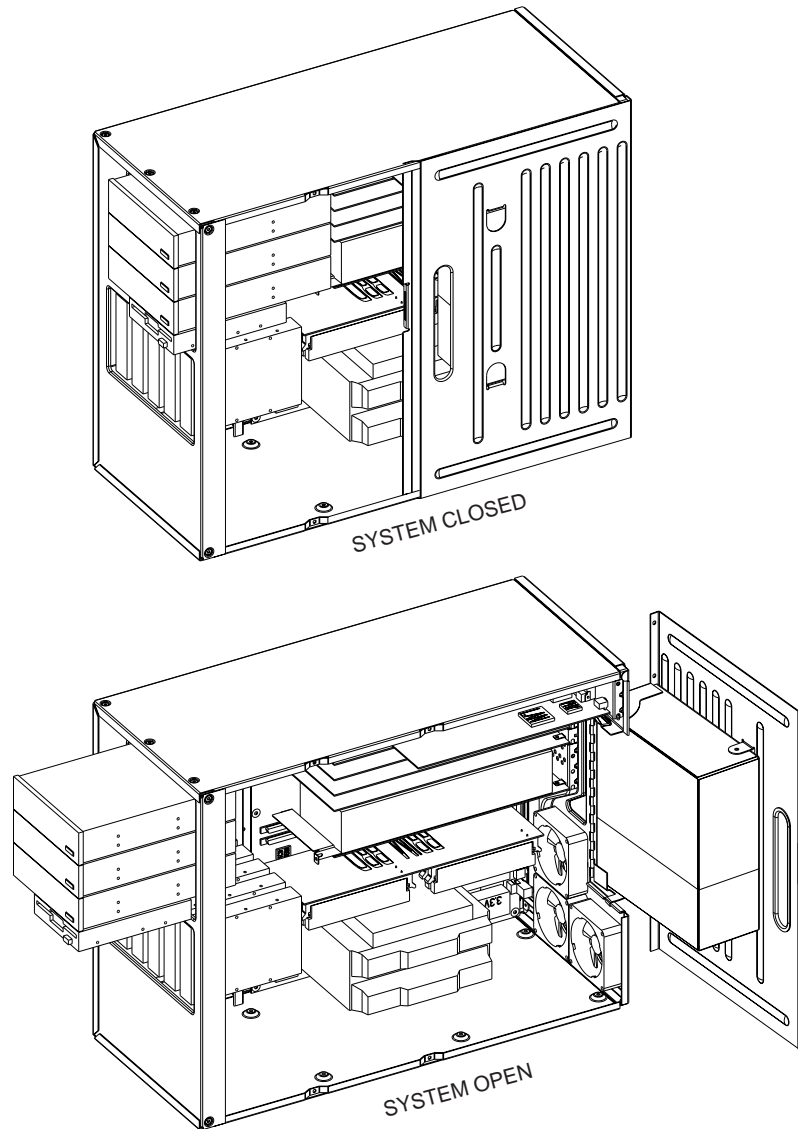
Figure 1. Example Configuration of a WTX-compliant System

2.5 Example Flex Slot Configuration

Flex Slot can provide a removable, customizable I/O card for WTX systems, offering the following advantages:

• Improved motherboard partitioning
  — Moving the I/O signals away from the traditional processor/memory/controller chip location improves routability.
• Improved Electromagnetic Interference (EMI) performance
  — Moving I/O connectors and their associated cables away from the strongest signal generators improves radiated noise generation.

- OEM differentiation
  — System providers can match I/O to customer needs, match I/O to system configuration for product line differentiation, or provide corporate I/O differentiation while using commodity motherboards.
- Time to Market
  — Using commodity motherboards while maintaining corporate identity accelerates product to market and lowers development costs.

A Flex Slot I/O card may include features such as PCI, audio, LAN, SCSI, serial and parallel ports, keyboard and mouse connections, USB, 1394, and system management features like fan speed control.
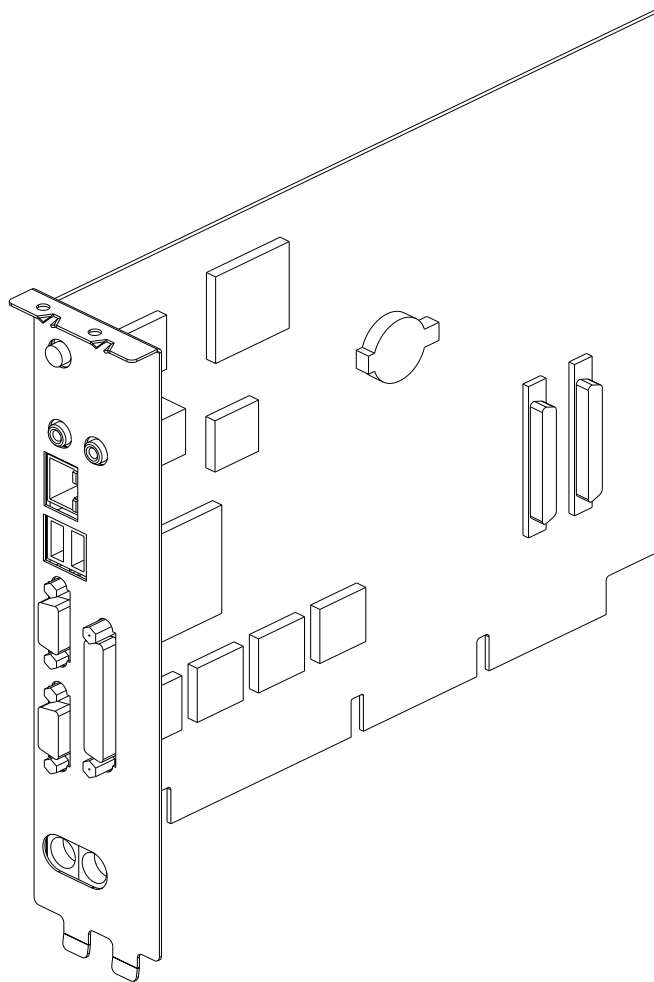
Figure 2 shows an example Flex Slot I/O card.

Figure 2. Example Flex Slot I/O Card

The I/O card is one possible implementation of Flex Slot. See Section 3.5 for additional information on Flex Slot.

3   WTX Mechanical Specifications

This chapter describes the mechanical requirements for a WTX motherboard, adapter plate, and chassis.

For dimensioning purposes, WTX provides three datum planes common through WTX component and system drawings. They are defined as follows:

- **Datum A** is established as the top (primary) side of the motherboard.
- **Datum B** is established through two datum holes and is parallel to the rear face of the motherboard.
- **Datum C** is established through a third datum hole and perpendicular to Datum B.

Including these datum holes in WTX boards, adapter plates, and systems is strongly recommended. In cases where the holes are not included, care must be taken to ensure features are properly located on the motherboard and the motherboard is correctly positioned on the adapter plate.

3.1 Motherboard Description and Dimensions

WTX supports motherboards with a maximum width of 14 inches [356mm] and a maximum length of 16.75 inches [425 mm]. There are no minimum motherboard dimensions. Board designers are free to determine their own optimum board size within the above guidelines.

Figure 3 illustrates WTX maximum board dimensions, sample connector locations, and mounting hole restrictions. The following connector layout is used to provide pin-1 data.
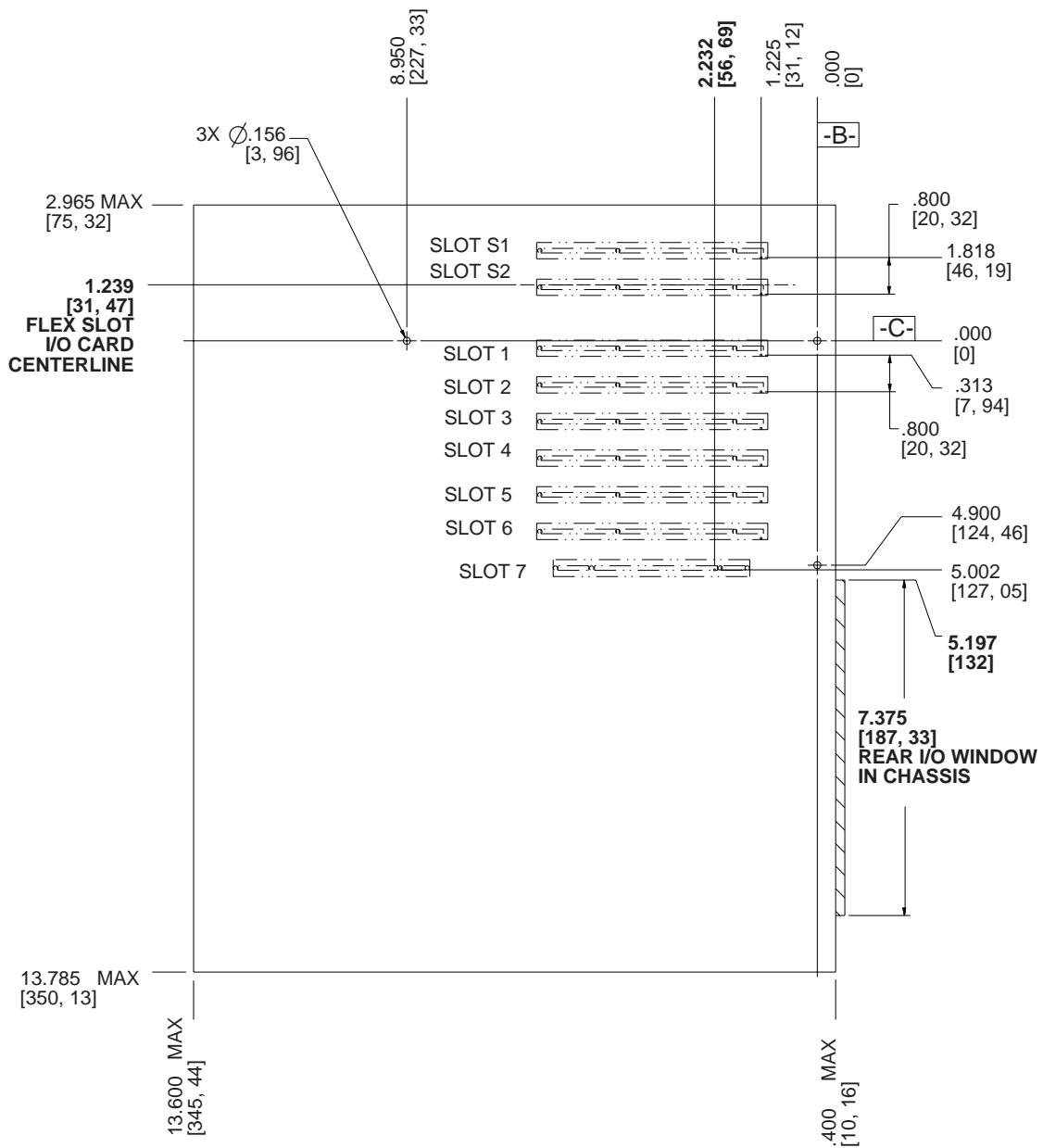
Figure 3. Maximum Motherboard Dimensions and Sample Connector Locations

Table 1.   Sample Connector Layout Locations

Slot Number	Connector Type and Pin ID
1	PCI Pin A1
2	PCI Pin A1
3	PCI Pin A1
4	PCI Pin A1
5	PCI Pin A1
6	PCI Pin A1
7	AGP Pro Pin A1
S1*	PCI Pin A1
S2*	PCI Pin A1

*   These positions represent PCI cards implemented in the Flex Slot volume.
     Dimensions for these connectors are for reference only.
     See Section 3.5 for additional information on Flex Slot.

This information can be used to calculate pin-1 locations for any connector layout.

WTX offers designers maximum flexibility by leaving motherboard mounting features and locations undefined. Motherboard suppliers must provide the adapter plate and ensure that the board-set is adequately constrained and grounded.

There are areas of the adapter plate that are not suited to receive board mounts. These areas are where material has been removed from the mounting surface of the adapter plate to create the features that lock into the chassis.

Figure 4 shows five areas on a motherboard that correspond to areas of the adapter plate that are not suited to receive stand-offs or similar mounts.

11.391 [289, 33]

8.950 REF [227, 33]

6.516 [165, 51]

1.641 [41, 68]

.000 [0]

-B-

.223 [5, 66]

-C-

.000 [0]

.077 [1, 96]

4.900 REF [124, 46]

6.078 [154, 38]

NOTE A

12.078 [306, 78]

12.078 [306, 78]

5X 1.015 [25, 78]

5X 1.470 [37, 34]

11.391 [289, 33]

1.641 [41, 68]
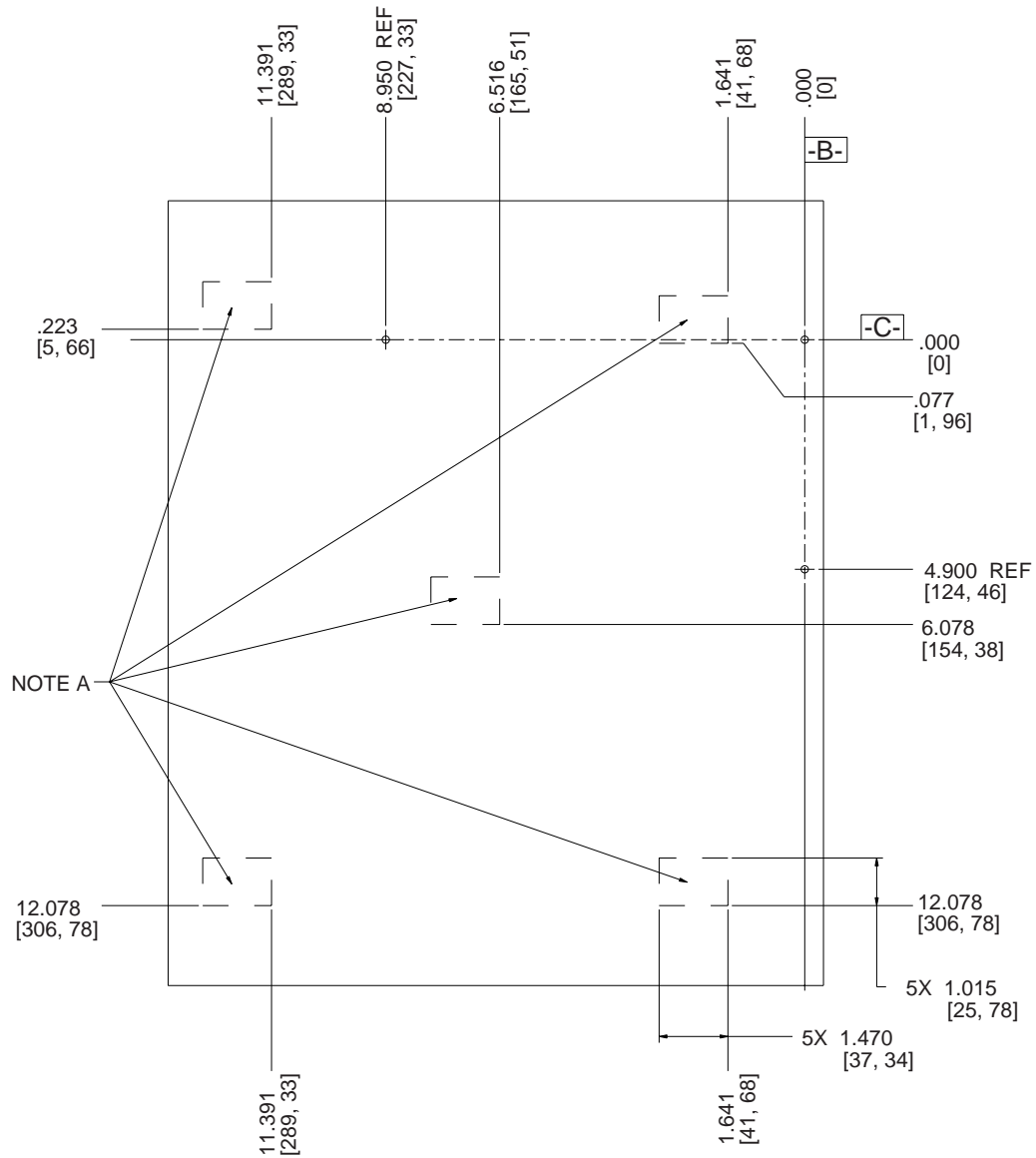
NOTE A: MOUNTING HOLE RESTRICTIONS EXIST 5 PLACES
COMPONENTS AND TRACES OK
SEE TEXT

Figure 4. Mounting Hole Restrictions

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3.2 Board-Set Volumetric

The board-set volumetric is defined as the volumes available on the adapter plate for motherboard designers. This primarily includes the motherboard and all attached daughterboards, expansion cards, risers, and any support mechanisms. It could also include components not mounted to the motherboard but carried on the adapter plate. Figure 5 shows the board-set volumetric.
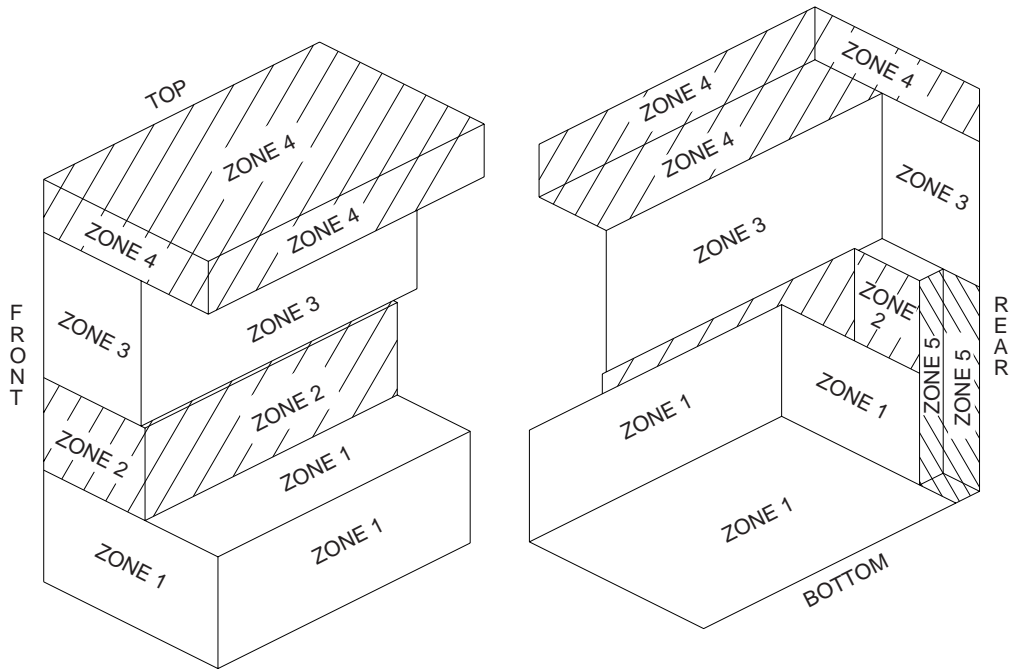
Figure 5. Board-Set Volumetric

Figure 6 details maximum volumes available for WTX board-set components. Motherboard designers must consider dynamic motion and clearance issues when placing components.
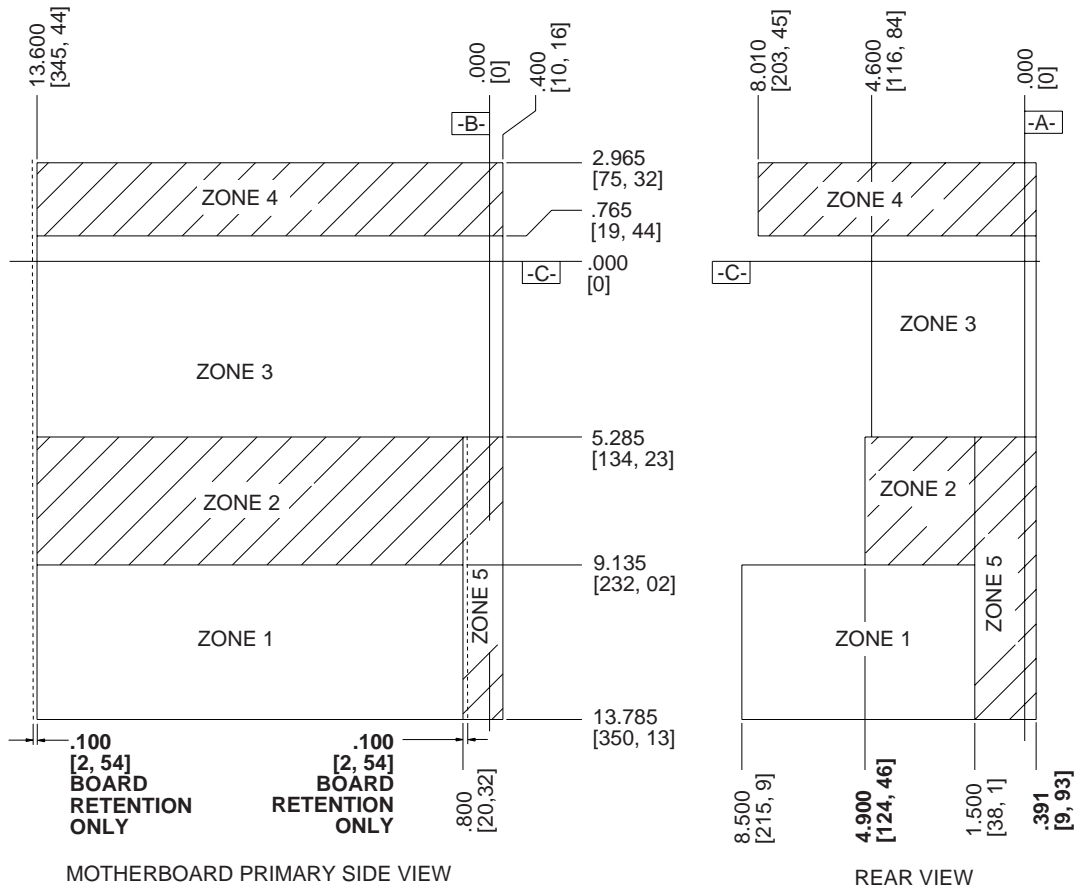
Figure 6. Maximum Board-Set Dimensions

Table 2 correlates the WTX volumetric with WTX chassis features. Example components are given for each zone that maximize chassis feature usage. Board designers may place components where best suited for individual designs given the trade-offs required.

Table 2.   Volumetric Zones and Related Chassis Features

Zone	Chassis Feature	Specification	Example Components
1	Board support mounting holes	See Section 3.4.4	Processor(s)
2	None	---	Memory
3	Rear panel expansion card openings	See Section 3.4.3	Expansion Cards
4	Rear panel Flex Slot opening	See Section 3.4.3	Flex Slot
5	Rear panel I/O opening	See Section 3.4.3	Motherboard I/O

3.3 Adapter Plate

Figure 7 shows a sample WTX adapter plate without motherboard mounting features.
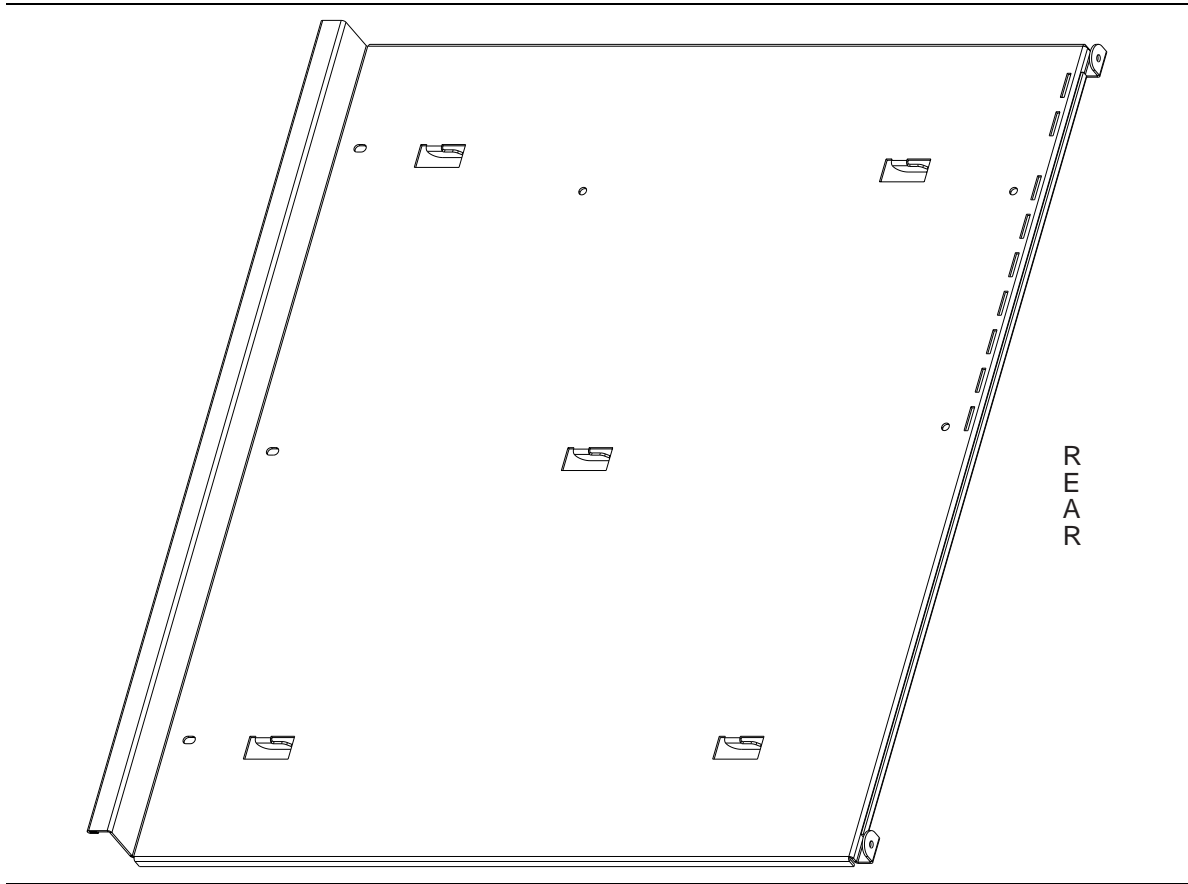
Figure 7. WTX Adapter Plate

WTX provides for an adapter plate to mount the board-set into the chassis. Motherboard suppliers must provide the adapter plate and ensure that the board-set is adequately constrained and grounded.

Figure 8 shows the top surface of the adapter plate. Figure 9 focuses on additional dimensions and details. Additional features used to mount the board-set to the plate are determined by the board designer. Datum holes are provided in the adapter plate to re-establish datums B and C; datum A remains the top surface of the motherboard.

Refer to the *WTX System Design Guide* for a sample implementation of a WTX-compliant adapter plate.
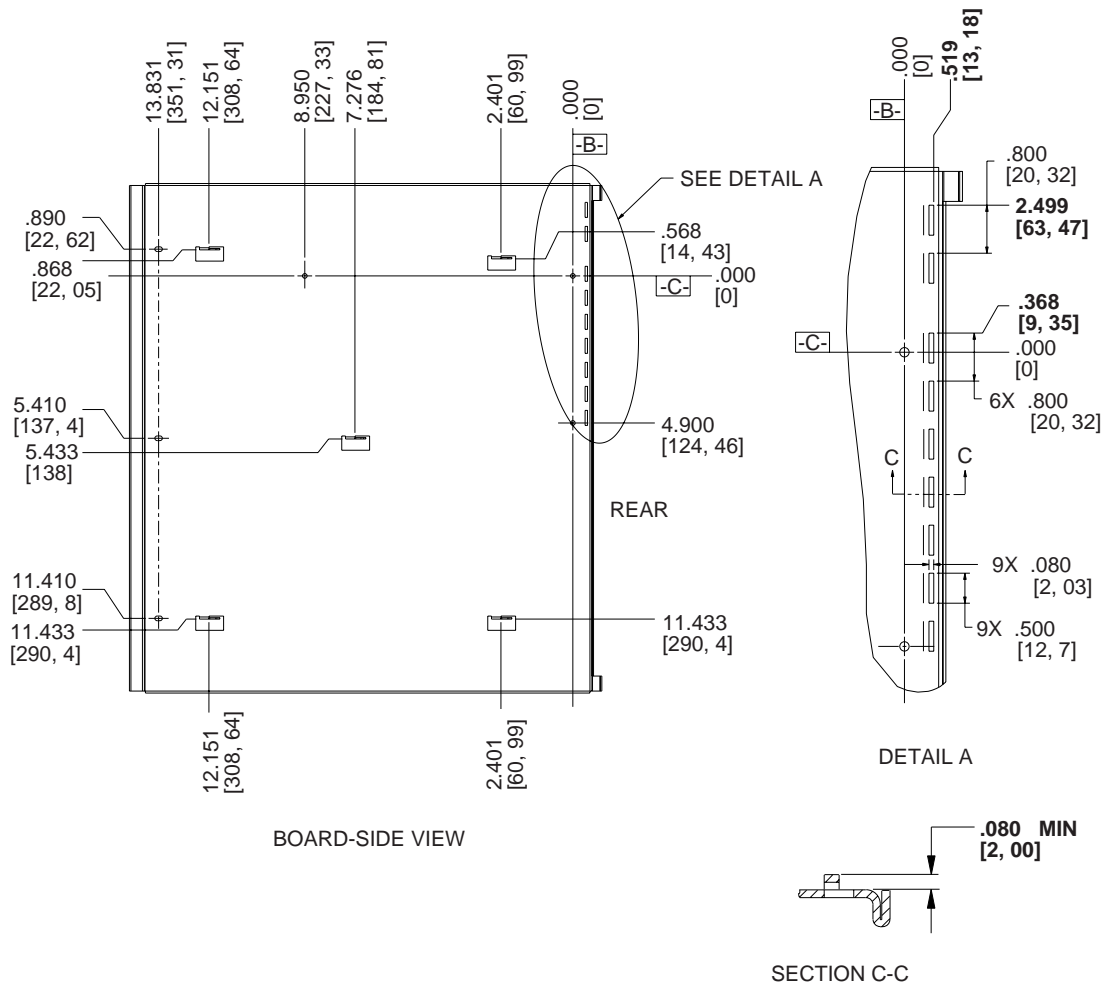
Figure 8. Adapter Plate Dimensions

SECTION B-B

.315 [8] .365 [9, 27] **.487 [12, 37]** -A-

.025 [0, 64] MAX BEND RADIUS   R.21 [5, 4]   45°±5°   2X R.06 [1, 5]

.20 [5, 1]

DETAIL OF HOOK
5 PLACES

2.401 REF [60, 99]

.490 [12, 45]   .440 [11, 18]   B   .100 [2, 54]   B   .000 [0]   -B-

.568 [14, 43]   REF   .000 [0]   -C-

.375 [9, 53]

BOTTOM VIEW

14.805 [376, 05]   14.305 [363, 35]

.539 [13, 69]

.391 [9, 93]

.641 [16, 28]

.000 [0]   .968 [24, 59]

-B-   -A-   .000 [0]   R E A R

.641 [16, 28]

REAR VIEW

13.582 [344, 97]

2X R.250 [6, 35]

2X 6-32 THD

.000 [0]   2.762 [70, 17]

-C-

-A-   .000 [0]   T O P

.391 [9, 93]
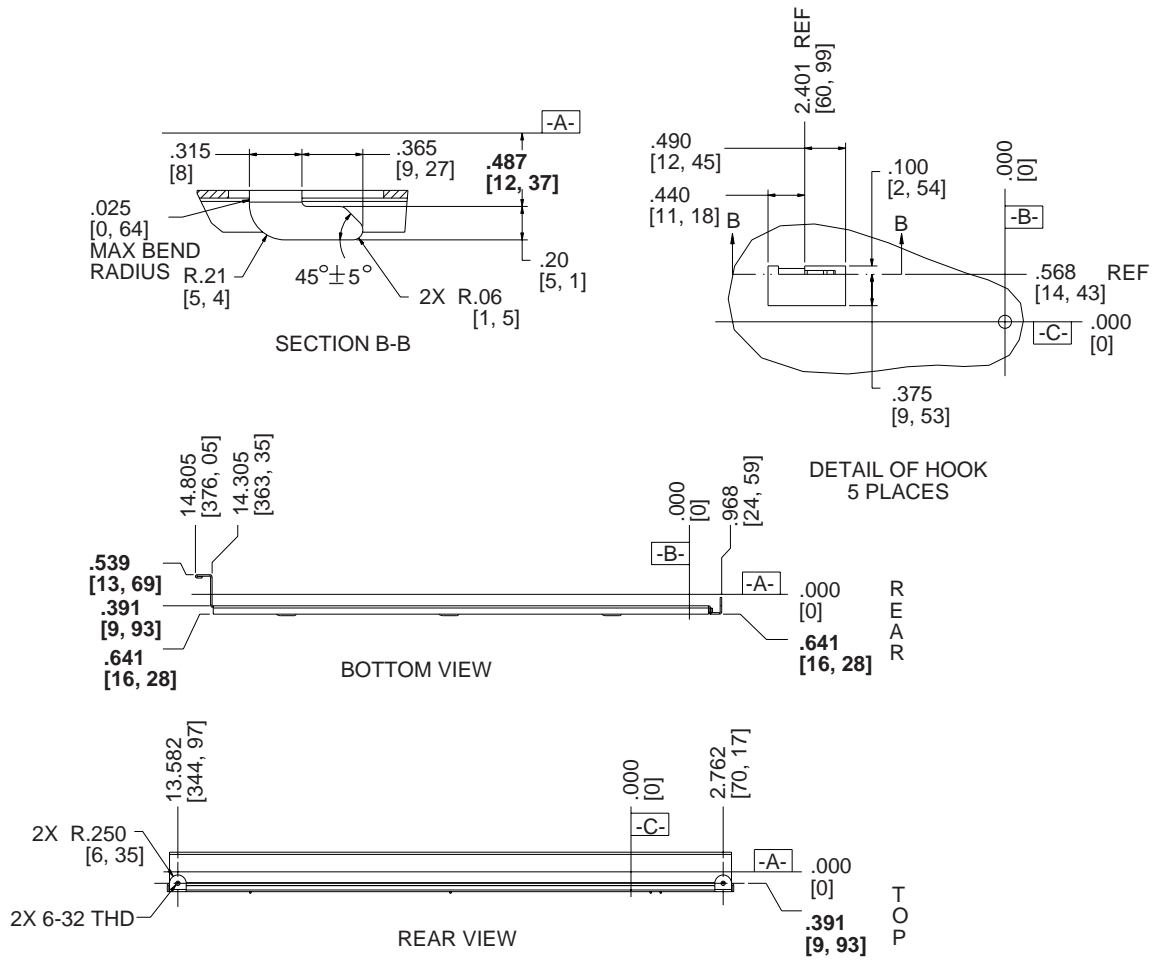
Figure 9. Adapter Plate Hook Detail

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3.4 Required Chassis Features

The following sections describe the features that are required on each face of a WTX chassis. Overall chassis size and construction can be determined by the designers. Refer to the *WTX System Design Guide* for a sample implementation of a WTX-compliant chassis. Figure 10 shows an exploded view of the board assembly (board-set and adapter plate).
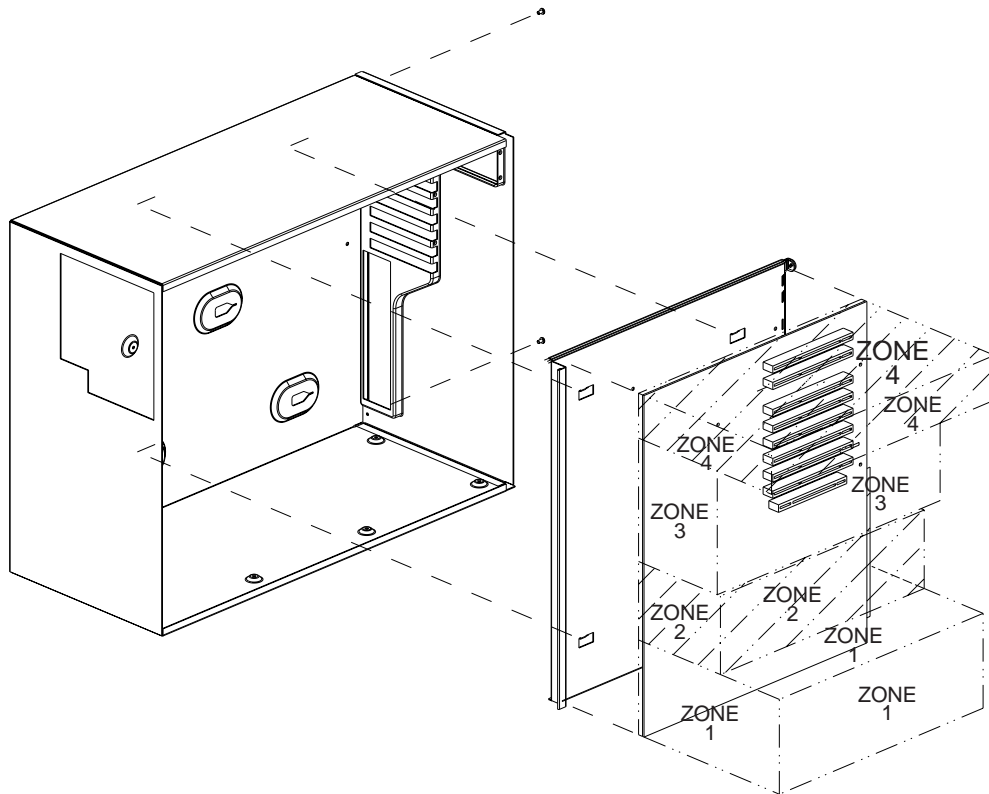
Figure 10. Exploded Board Assembly

3.4.1   Chassis Volumetric Zone

Figure 11 illustrates the chassis volumetric. The volumes of Zone 1 through Zone 5 are defined in Section 3.2. Zone 6 is the volume of the adapter plate and defined chassis features. It is recommended that chassis designers allow a 0.250 inches [6.36mm] clearance around all volumes to allow for dynamic motion.

Figure 11 also illustrates the volume required to insert and remove the board assembly. Clearance is required in front of the board-set to allow the adapter plate hooks to clear the chassis slots. This area must be kept clear of *permanent* chassis and system components.

Figure 11. Chassis Volumetric

3.4.2 Chassis Left Panel Features

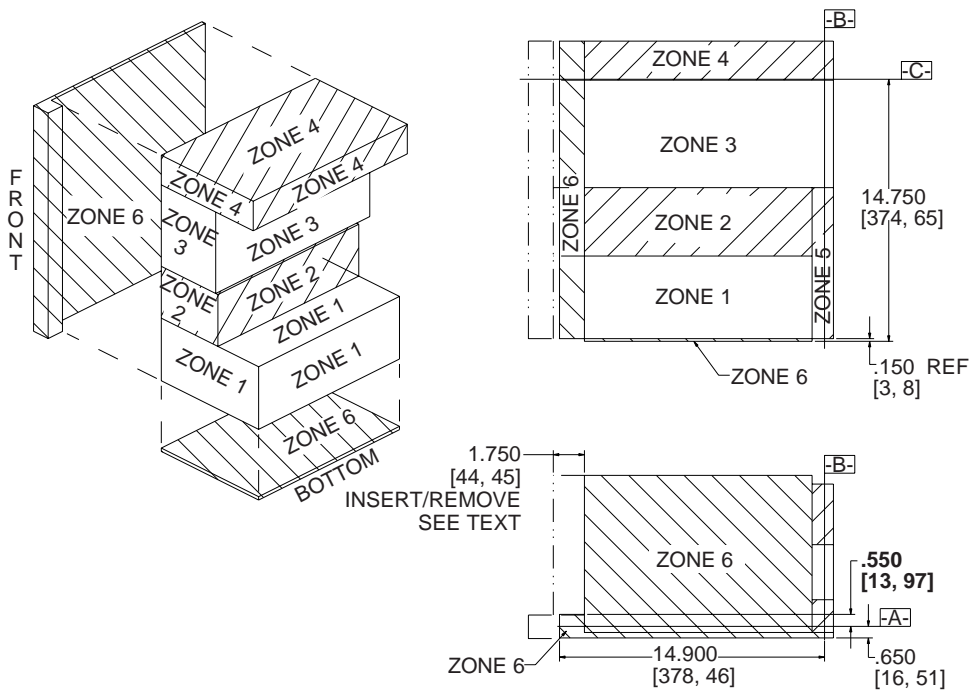The left panel of the chassis (bottom in a rack-mount configuration) receives the hooks on the adapter plate. The hooks engage and lock into slots raised on forms to provide backside clearance for the hooks and provide front side clearance for the adapter plate perimeter flanges. Figure 12 details these chassis features. Datum holes are provided in this panel to re-establish datums B and C; datum A remains the top surface of the motherboard.
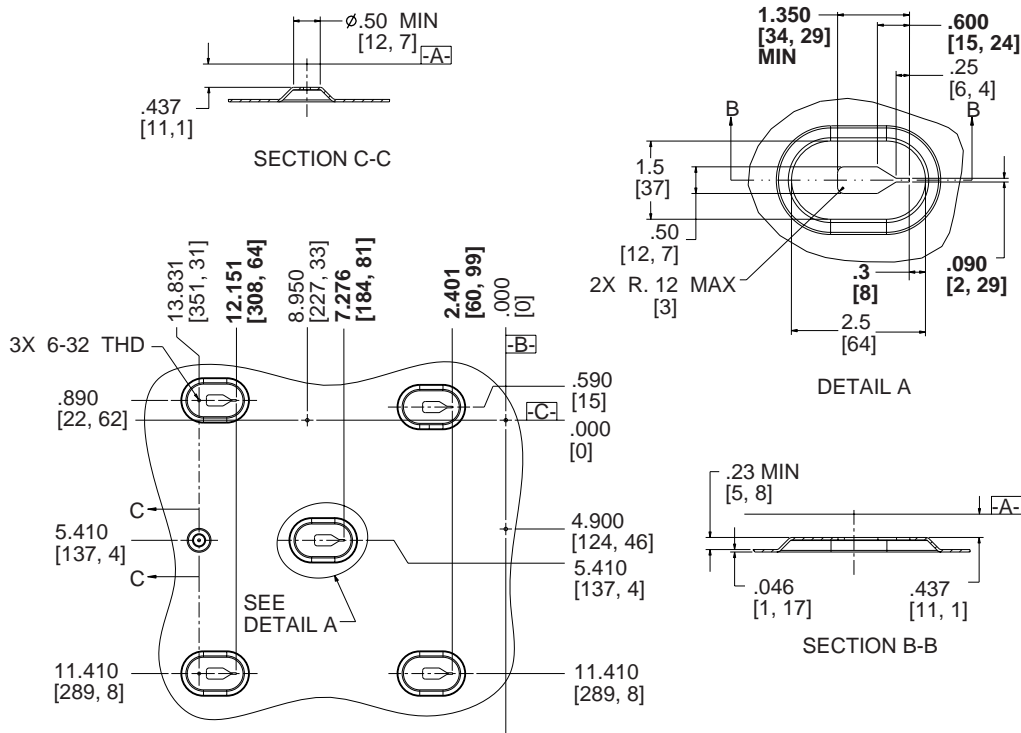
Figure 12. Chassis Left Side Panel

3.4.3 Chassis Rear Panel Features

The rear panel of a WTX chassis must accommodate the following:

- Adapter plate retaining screws
- Motherboard back panel I/O shield
- Expansion cards
- Flex Slot

Figure 13 shows the details of the chassis rear panel. Expansion card opening locations are given as reference. They can be calculated based on connector locations given in Section 3.1.

The adapter plate attaches to Plane H as shown in Figure 13. The expansion card brackets and the back panel I/O shield attach to Plane G as shown in Figure 13. Designers must include the appropriate offset to ensure adapter plate compatibility. See Section 3.3 for additional information about the adapter plate.
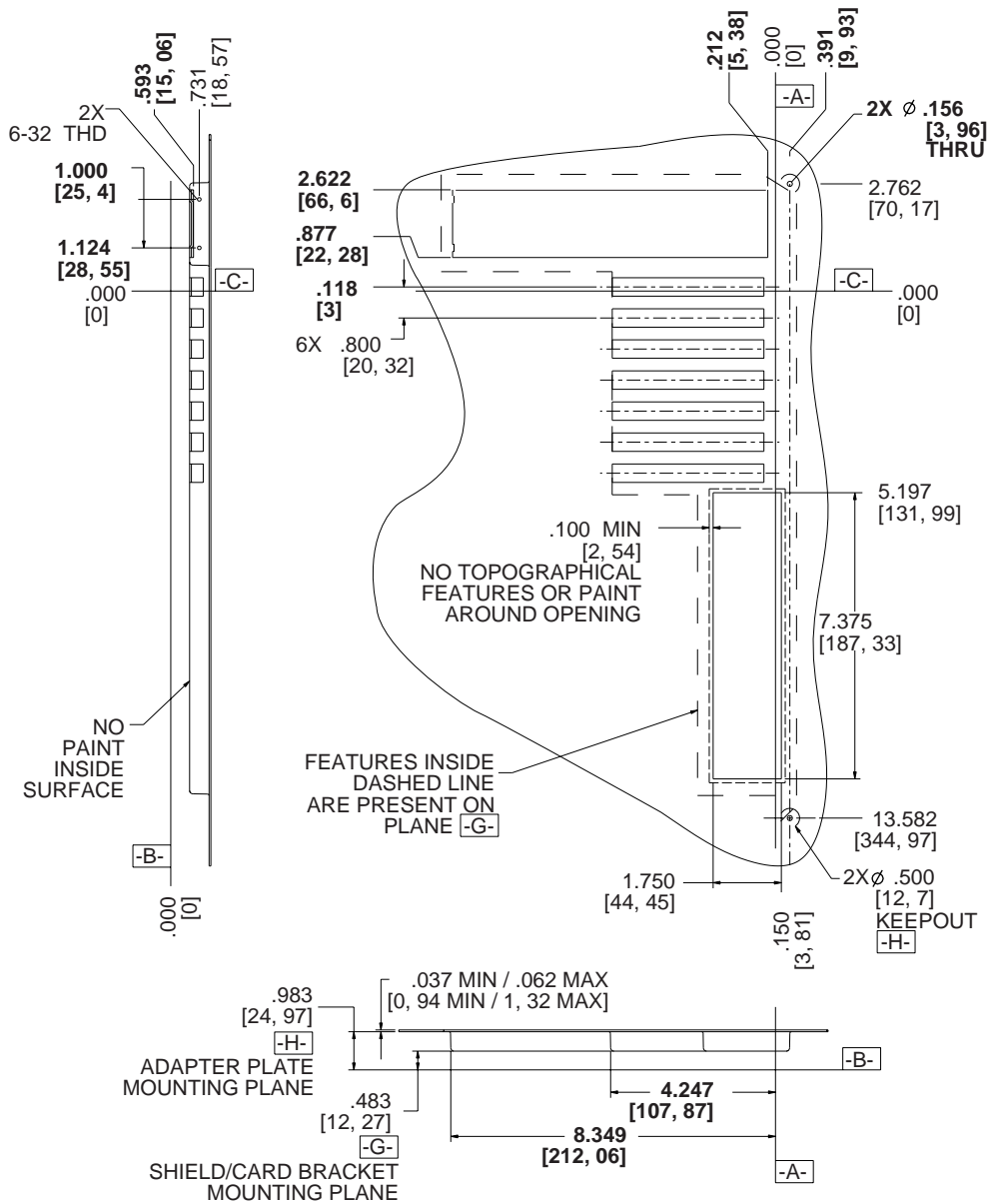
Figure 13. Chassis Rear Panel

3.4.4   Chassis Bottom Panel Features

To provide mechanical support for future processors and other tall components, WTX chassis' must provide the features illustrated in Figure 14 on the bottom panel of the chassis (right side in rack configuration). These features are attach points for board assembly components and supports. Supports and brackets are unique to each board-set and must be provided by the board manufacturer.
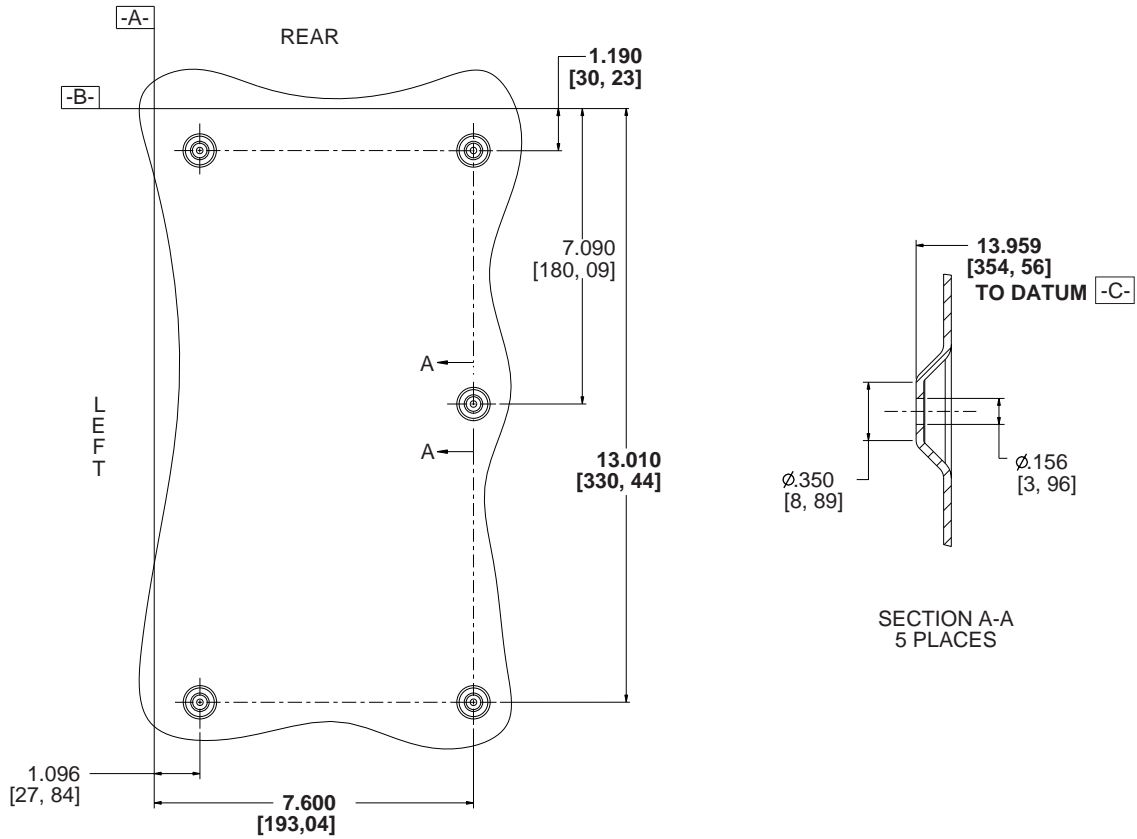
Figure 14. Chassis Bottom Panel

3.5 Flex Slot

Flex Slot is an additional board-set volume and rear panel opening for the chassis. It is intended to provide an additional path from the board-set to outside the chassis beyond expansion card slots and the motherboard I/O opening. A WTX chassis must support the Flex Slot volume (Section 3.2) and the Flex Slot rear chassis opening (Section 3.4.3).

Flex Slot has been sized to accommodate two standard expansion cards within the volume and opening defined. Refer to the *WTX System Design Guide* for a sample implementation of a Flex Slot.

3.5.1 Flex Slot Filler Panel

Figure 15 shows a Flex Slot filler panel. This panel may be used as a reference for any Flex Slot bracket. The Flex Slot filler panel should be given the same consideration as expansion card filler panels regarding mechanical mounting and electromagnetic interference and containment. See Chapter 5 for additional information on electromagnetic interference and containment.
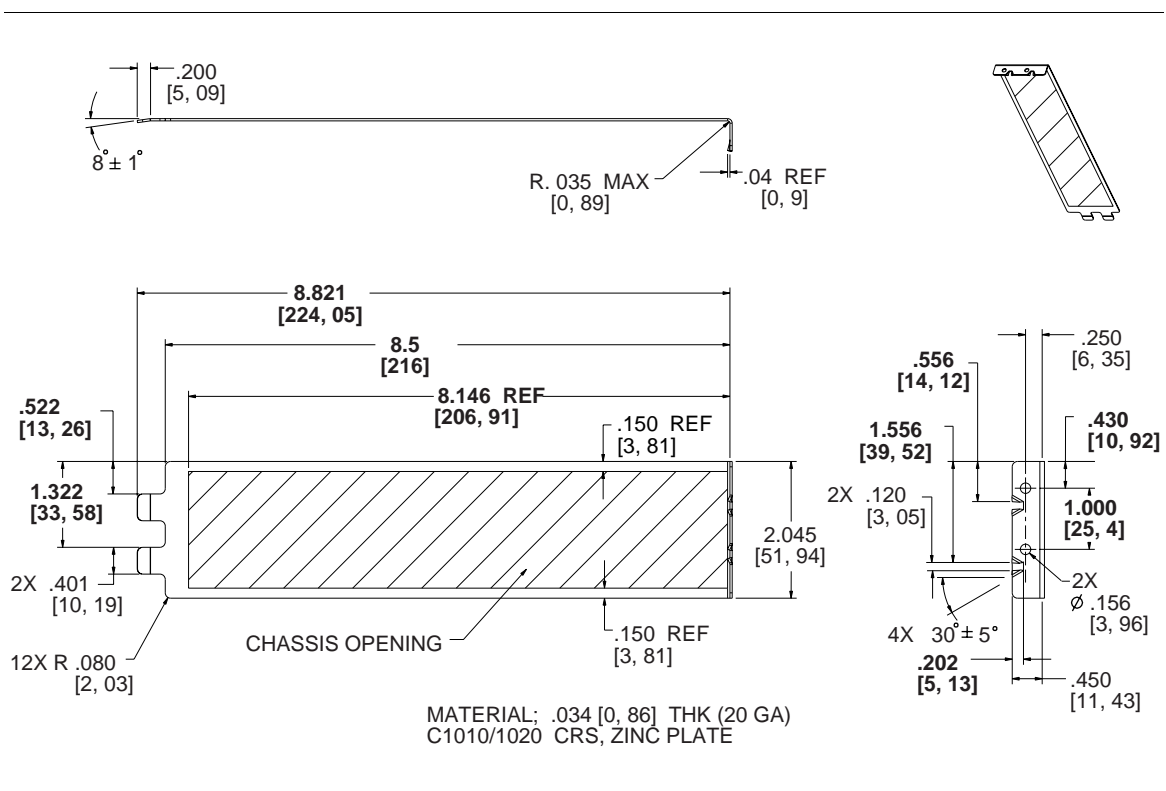
Figure 15. Reference Flex Slot Filler Panel

3.5.2 Flex Slot Adapter Bracket

Flex Slot has been sized to accommodate two standard expansion cards in the Zone 4 volume. These cards utilize the Flex Slot chassis rear opening; however, an adapter bracket is needed to provide the required mounting planes and mounting holes.

Figure 16 illustrates an example adapter bracket. To ensure full compatibility with all WTX board-sets, a WTX chassis should have an adapter bracket available. The chassis designer can determine the exact geometry and attachment for the bracket.
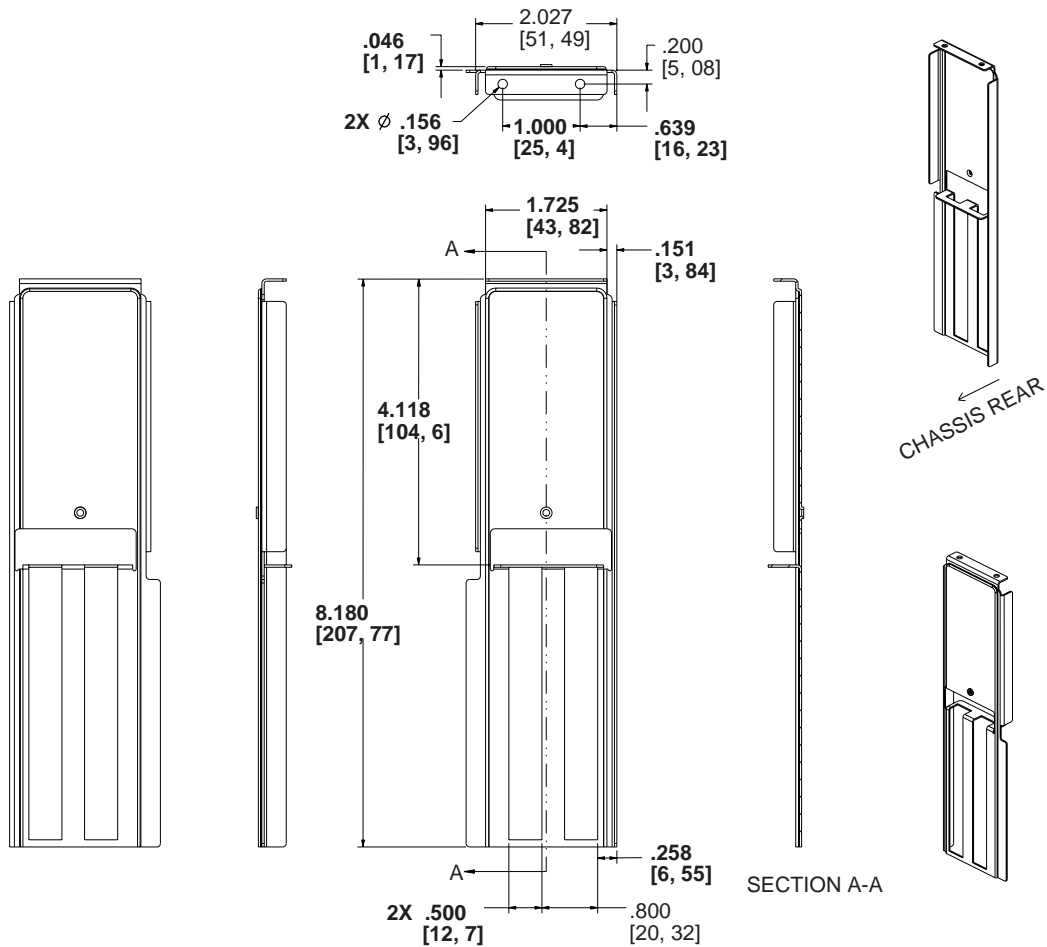
Figure 16. Flex Slot Adapter Bracket

4 Thermal Management

4.1 Design Requirements

Proper cooling of processors, memory devices, and I/O adapters is essential to the performance and reliability of a workstation. Each new combination of motherboard, processor, and memory should be investigated to ensure that design maximum component temperatures are not exceeded under worst case environmental conditions, i.e., room ambient temperature and altitude. In addition, board designers may need to include temperature sensors and shutdown circuits to protect unusually high-power components that may exceed safe temperatures in some chassis types.

4.2 Design Recommendations

This chapter is intended to aid system designers in providing adequate cooling for workstation applications; it provides guidelines regarding fan size, placement, and airflow direction. These are basic system guidelines and are not intended to be a substitute for thermal engineering and testing. Due to the large number of possible variables, no guarantees can be made regarding system thermal performance. The information provided here is based on testing, modeling, and experience.

Additional information may be found in the *WTX System Design Guide.*

4.2.1 Thermal Zones

It is no longer possible to treat the entire chassis as a whole when designing for cooling. Certain components have special cooling requirements. The most obvious is the processor(s), but memory boards are becoming notable components that need special attention. The growth of memory speed and size will further require that the system integrator accounts for the thermal load contributed by the memory boards. The purpose of defining these zones is to demonstrate the different cooling requirements and develop methods of optimizing them.

WTX thermal management is based on thermal zones. Zone requirements are defined by the components recommended to be present in each. The goal of this zoned thermal approach is to provide a system design with thermal headroom. Figure 17 defines the thermal zones as they correspond to the board-set volumetric.
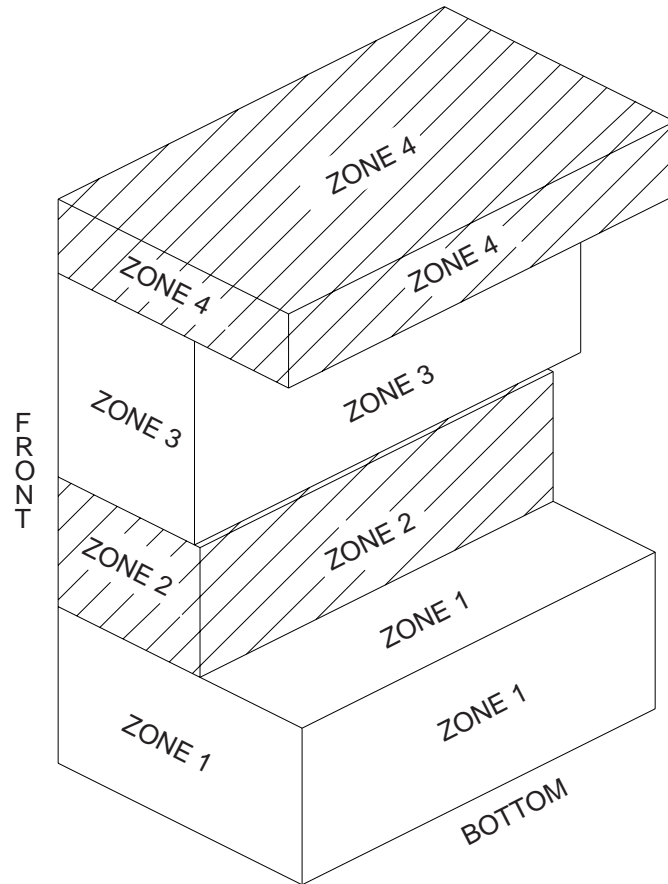
Figure 17. Thermal Zones

- Zone 1 manages the thermal requirements of the recommended placement of the processor(s) and associated components.
- Zone 2 manages the thermal requirements of the recommended placement of system memory and associated components.
- Zones 3 and 4 manage the thermal requirements of AGP, expansion cards, Flex Slot I/O, and motherboard-mounted chipsets.

One or more fans cool each of these zones. These fans may be thermally-controlled. Placement of these fans helps define the zones and ensures that adequate airflow is provided. In addition, independent thermal control of each zone will provide thermal compliance and minimize system acoustics.

4.2.2 Zone Airflow

In general, the system fans must provide enough airflow so that air temperature rise does not exceed 10 °C throughout the system. As an example, in a system where 400 W of power is dissipated, the airflow required to maintain a 10 °C air temperature rise is approximately 72 CFM. Because all fans are rated at 0 inches static pressure, fans or blowers with CFM rating of 20%-30% higher will be required, depending on the system's impedance.

Table 3 shows fully loaded power dissipation and recommended airflow and equivalent fan ratings for each zone.

Table 3.   Thermal Zone Cooling

Zone	Component	Power Dissipated (W)	Recommended Air Flow (CFM)	Recommended Fan Rating (CFM)
1	Processors	400	72	90
2	Memory	200	36	45
3	AGP-Pro	110		
3	Expansion Cards	100	41	52
4	Flex Slot I/O	20		

A WTX chassis should be capable of providing the zone airflows listed in Table 3. To provide an optimal performance and cost balance, system designers may match zone airflows to system configuration and customer requirements by derating or depopulating fans or by developing unique control systems.

4.2.3   Motherboard Components and Hard Drives

Some motherboard components such as chipsets and clock buffers can require airflow rates of as much as 200 LFM for proper cooling unless special heat sinks are used. Increasing the quantity, size, and speed of fans to obtain higher flow rates may not always be cost effective, and it increases system noise levels. Since a manufacture of a generic chassis cannot foresee special cooling problems of this type, motherboard manufacturers must provide heat sinks to adequately cool their products with the expected airflow rate.

Adequate airflow must also be provided around the hard drives, especially the PCB and HDA (Head and Disk Assembly), to meet manufacturers requirements for operation and reliability. If airflow is inadequate in this area, conduction cooling or a hard drive heat sinks should be considered.

5 Electromagnetic Interference and Containment

5.1 Design Requirements

The Electromagnetic Interference (EMI) performance of a system is determined by the degree of noise suppression designed into the motherboard and the provisions for electromagnetic interference containment in the chassis design, including placement of internal subsystems and cables.

In recent years, marketing requirements have changed for workstations and now call for compliance to more stringent electromagnetic interference compatibility (EMC) limits such as the CISPR-22 European standard or the U.S. FCC "B" standard. These more restrictive standards, along with higher processor and video frequencies, call for additional chassis containment provisions. The basic design principles have not changed, but the shorter wavelengths call for more frequent ground contacts and shorter apertures.

5.2 Design Recommendations

This chapter is intended to aid system designers in providing adequate electromagnetic interference and containment for workstation applications. This chapter also provides guidelines regarding aperture sizing, shield contact, and spring stock placement. These are basic system guidelines and are not intended to be a substitute for EMI engineering and testing. Due to the large number of possible variables, no guarantees can be made regarding system EMI performance. The information provided here is based on testing, modeling, and experience.

Engineering guidelines recommend restricting slot lengths to 1/20 of a wavelength of the highest frequency of interest. This is based on the radiating efficiency of a slot versus the wavelength of emission. The WTX form factor encompasses processors up to the gigahertz operating speed range (requiring testing up to 5 GHz), corresponding to a 0.125 inch [3.18mm] slot. This dimension may be impractical given the necessity of providing adequate airflow, mounting components, and providing structure. A compromise is to target a nominal aperture of 0.250 inches [6.35mm] during chassis development, with prototype testing to identify weak points.

5.2.1 Motherboard Grounding

The motherboard needs to tie into the chassis with the lowest electrical impedance possible. Motherboard mounting features must provide good ground paths into the adapter plate; this is the responsibility of the board designer. In addition, the adapter plate should be well grounded to the main chassis. Otherwise, the motherboard can begin to "float" at frequencies in the RF range due to the high impedance of the ground return to chassis, which could enable the entire board/plate structure to act as an antenna or cause excessive noise to be conducted to external cables. Good plate-to-chassis contact is required at the five hook/slot locations and at the screw locations defined for both the adapter plate and the chassis. All metal components must be galvanically compatible through the grounding path.

5.2.2   I/O Shield

The I/O shield for the motherboard connectors is one of the most critical aspects of limiting EMI. Poorly grounded connectors will allow noise to escape on their associated cables. Also, weak connector grounding can make a motherboard much more susceptible to functional errors or damage from electrostatic discharge (ESD).

The I/O shield should make secure contact to the metal connector faces at multiple locations, with spacing between contacts not to exceed 0.250 inches [6.35mm] at both the bottom and top of each connector D-shell. Spring fingers formed from the bracket material are the preferred method. Conductive I/O gaskets can work, but tend to be more expensive and typically do not provide as low an impedance as metal-to-metal contact. Make sure the finger length and bend angle assure enough deflection when installed to guarantee a solid contact. Some connectors, such as those for audio, LAN, or USB require a more creative design of contact finger due to their shape. These ports require a good ground just as the D-shell connectors do. The I/O shield must provide a contact finger for every port.

The I/O shield must make contact to the chassis opening around the entire perimeter of the part, with spacing between contacts not to exceed 0.25 inches [6.35mm]. The chassis contact area must be free of any paints, labels, or mechanical irregularities that would prevent good metal-to-metal contact.

5.2.3   Option Card Brackets

Option cards frequently exhibit a gap between the card bracket and the rear of the chassis, resulting in a slot of up to 4 inches [100mm]. This can be avoided by the use of spring finger stock that is inserted prior to the cards. The option cards retention screws are used to keep the finger stock strip in place.

A similar situation exists for using the Flex Slot bracket, although the resulting slot can be up to 8 inches [200mm]. Finger stock may also be used to reduce the size of this gap.

5.2.4   Disk Drives

Always provide a method of grounding the disk drives to the chassis. This is necessary for emissions and ESD performance. An electrical path through the drive mounting screws is generally adequate.

There are often very large slots above and below external disk drives. Prototype testing may require spring clips or gasket material to be inserted to cut down the slot length. Chassis designers should anticipate this requirement and ensure appropriate mounting features are incorporated into the design.

5.2.5   Cover Clips

Since the access cover generally presents the longest aperture in the system, plan on including a retention mechanism for EMI spring clips along the length of the chassis/cover interface surface. The cover should have some overlap at the chassis contact area so that there is not a direct "line of sight" escape path for emissions. If this is not possible, then gasket material may be necessary to seal up the seam.

5.2.6 Internal Cable Routing

Internal cables can pick up noise from the electronics inside the chassis and act as efficient antennas at certain frequencies, depending on the length and construction of the cable. Avoid running internal cables directly over processors, clock chips, video chips, and plug-in option cards. Cables should be routed away from seams, cooling vents, and other chassis apertures.

Internal cable routings are determined by several factors besides electromagnetic interference and containment, such as ease of assembly, thermal, and shock and vibration concerns. Before determining the final routing plan, an EMI engineer should be consulted.

6 Power Delivery

This chapter details the requirements and guidelines to deliver DC voltage and power control signals to the board-set(s) of mid-range WTX workstations.   It includes information on form factors, cooling requirements, and connector configurations. It is augmented by the *WTX Power Supply Guidelines* which includes suggested features and sample configurations. It is not, however, intended to replace or supersede the user's independent design and validation activities.

Refer to the *WTX Power Supply Guide* for specific details.

6.1 Power Supply Form Factors

Two power supply form factors have been adopted to meet the power requirements of WTX compliant systems. These form factors enable the system designer to develop power supply delivery solutions suited to the individual system configuration. The typical mid-range WTX workstations will vary between 350W and 850W (depending upon the specific board and system configurations).

6.1.1   Single Fan Power Supply

The single fan power supply is intended to satisfy the lower power (350 W plus) configurations of mid-range WTX systems. Its physical characteristics (including size and mounting and venting locations) shall comply to the requirements detailed in Figure 18.

Refer to the *WTX Power Supply Guide* for information about output cable placement.

Unless otherwise specified, all dimensions are in mm. Tolerances;

xx. ±1
x.x ±0.5

Note 1. Fan detail is shown for illustration only - actual detail should be optimized for EMI, airflow and acoustic considerations. Fan grill and AC recepticle positions and orientations are shown for illustration only - Fan and AC inlet must be positioned within area shown. All detail and screwheads must be flush to power supply surface.

Note 2. Optional location for cable exit - refer to WTX Power Supply guidelines.

Figure 18. WTX Low Power Supply Envelope

6.1.2 Dual Fan Power Supply

The dual fan power supply is intended to satisfy the requirements for higher power configured mid-range workstations (up to 850 W). Its physical characteristics (including size and mounting and venting locations) shall comply to the requirements detailed in Figure 19.

Refer to the *WTX Power Supply Guide* for information about output cable placement.
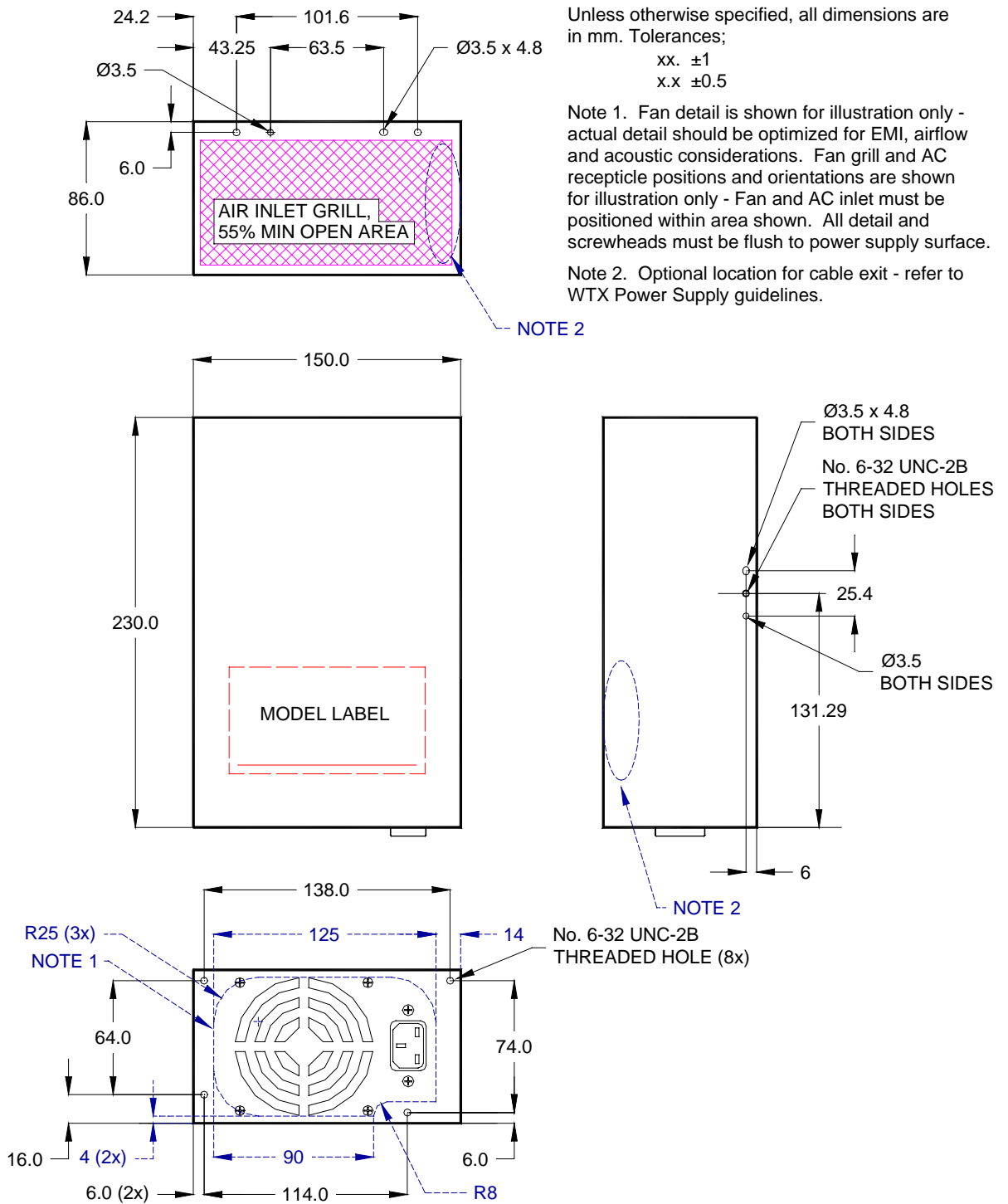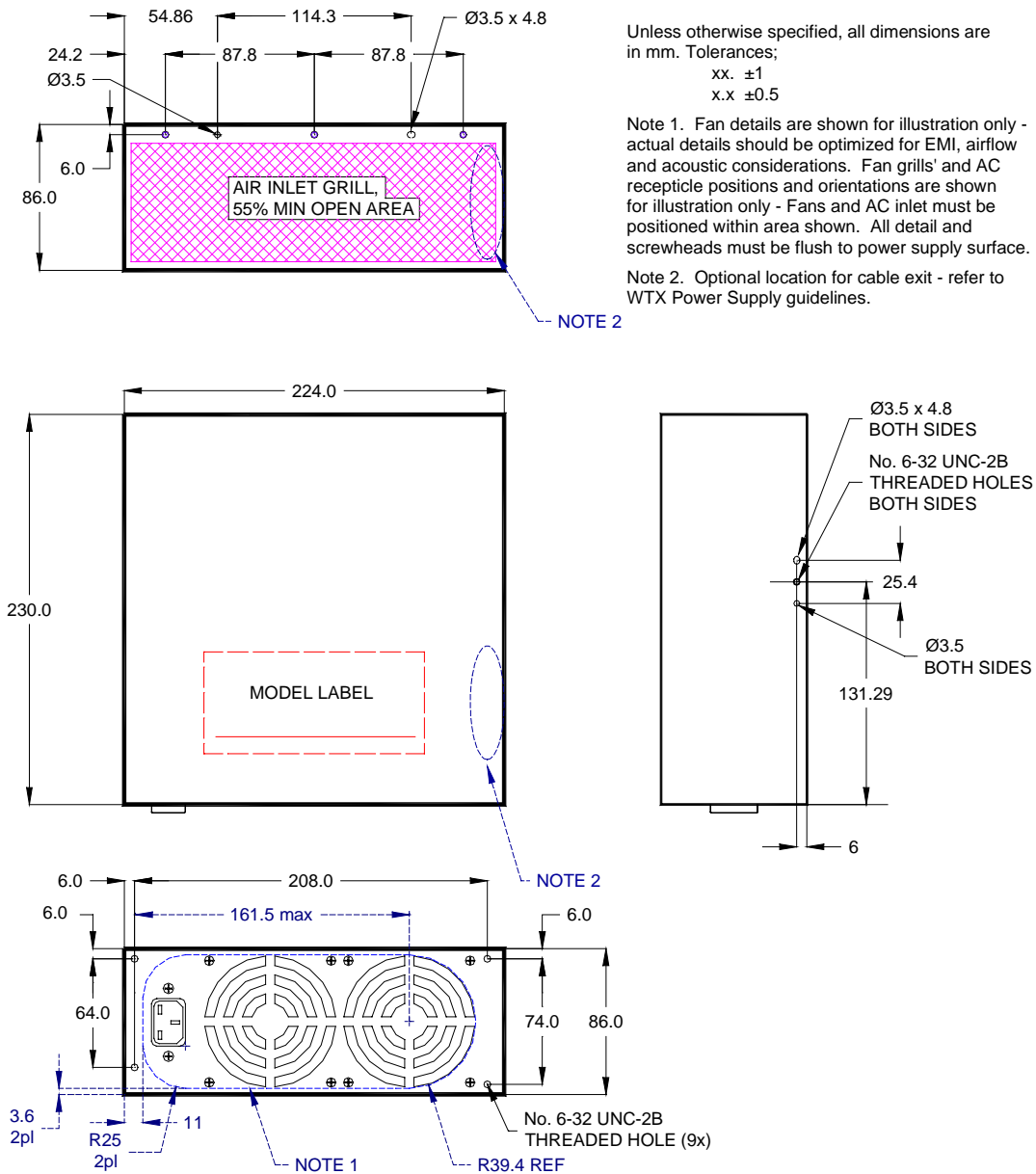

Figure 19. WTX High Power Supply Envelope

6.1.3   Power Supply Airflow

The airflow direction shall be such that the power supply assists in system cooling in addition to its own intrinsic thermal management.

The power supply is intended to exhaust system air. The exact venting location and geometry and fan selection may vary depending on cooling, acoustic noise suppression, and EMI control.

6.1.4   Power Supply Output Connections

Refer to *WTX Power Supply Guide* for specific details.

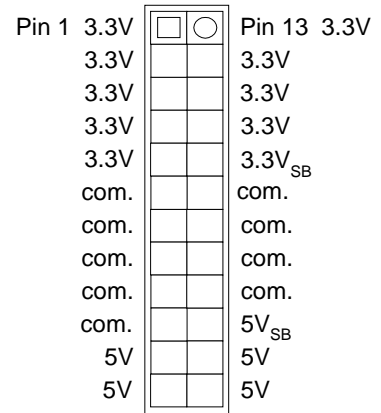## 6.2   Approved Board Connectors

The following details the approved connectors for power delivery on WTX compliant board-set(s).

6.2.1   Main Power Connector – 24 Pin

MOLEX 39-29-9242 or equivalent.

This connector provides the 3.3V and 5V (including standby and auxiliary) voltages to the board set(s) of WTX compliant systems.

The pin reference designations shall be as illustrated.

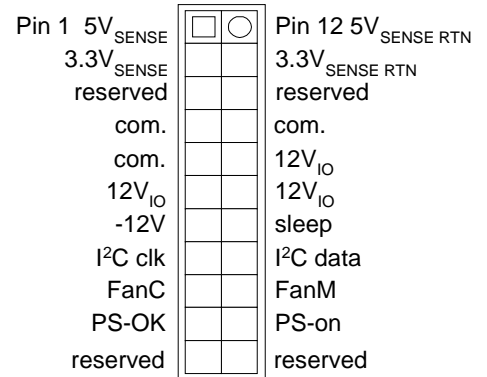| Pin 1 3.3V			Pin 13 3.3V
3.3V			3.3V
3.3V			3.3V
3.3V			3.3V
3.3V			$3.3V_{SB}$
com.			com.
com.			com.
com.			com.
com.			com.
com.			$5V_{SB}$
5V			5V
5V			5V

6.2.2   Additional Power Connector – 22 Pin

MOLEX 39-29-9222 or equivalent.

This connector provides the 3.3V and 5V (including standby and auxiliary) voltages to the board set(s) of WTX compliant systems.

The pin reference designations shall be as illustrated.

| Pin 1 $5V_{SENSE}$			Pin 12 $5V_{SENSE\ RTN}$
$3.3V_{SENSE}$			$3.3V_{SENSE\ RTN}$
reserved			reserved
com.			com.
com.			$12V_{IO}$
$12V_{IO}$			$12V_{IO}$
-12V			sleep
I^2C clk			I^2C data
FanC			FanM
PS-OK			PS-on
reserved			reserved

6.2.3 12V$_{DIG}$ VRM/D2D Output Power Connector – 8 Pin

MOLEX 39-29-9082 or equivalent.

This connector provides 12V DC power to D2Ds (DC-DC converters) and/or VRMs (Voltage regulator modules) used to power microprocessor or large memory configurations

The pin reference designations shall be as illustrated.

Pin 1 12V$_{DIG}$ Pin 5 com
12V$_{DIG}$ com.
12V$_{DIG}$ com.
12V$_{DIG\ SEN}$ 12V$_{DIG\ SEN\ RTN}$
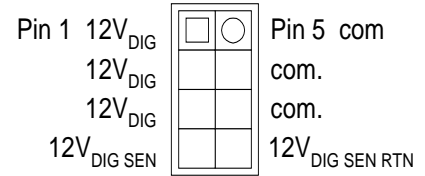
6.2.4 12V$_{CPU}$ VRM Power Connector – 6 Pin

MOLEX 39-29-9062 or equivalent.

This connector provides 12V DC power to VRMs (Voltage regulator modules) used with higher power microprocessor ors. It shall be routed via harness to either the board set(s) or direct to the VRM/PowerPods.

The pin reference designations shall be as illustrated

Pin 1 12V$_{CPU\#}$ Pin 4 com
12V$_{CPU\#}$ com.
12V$_{CPU\#}$ com.
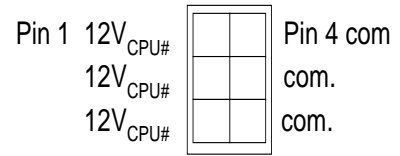
6.3 Connector Pin Definitions

Refer to *WTX Power Supply Guide* for application and additional clarification of power supply signals.

Table 4. **Connector Pin Definitions**

Term	Definition
PS-On	Signal to enable/disable power supply
Sleep	Signal to disable all outputs except 5V$_{SB}$, 3.3V$_{AUX}$ and 12V$_{DIG}$ for suspend operations
PW-OK	Signal indicating all power supply outputs within limits
I2C clock	Clock signal for I2C interface
I2C data	Data signal for I2C interface
xVsense	Sense line for xV power supply output
xVsense rtn	Provides return path for xV power supply sense line
FanC	Signal to control fan speed in power supply
FanM	Signal indicating fan speed/status in power supply
Reserved	Unassigned pins reserved for future definition