PCI Express®
225 W/300 W High Power Card Electromechanical Specification
Revision 1.0RC

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0.9	PCI-SIG member review draft	12/17/07
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Objectives of the Specification

The main objective of this specification is to support PCI Express® add-in cards that require higher power than specified in the *PCI Express Card Electromechanical Specification* and the *PCI Express x16 Graphics 150W-ATX Specification*. This specification includes the following:

- System implementations
- Card power
- Auxiliary power connectors
- Mechanical specification
- Thermal and acoustic management

Reference Documents

PCI Express Base Specification, Rev. 2.0 (PCI Express Base 2.0)

PCI Express Card Electromechanical Specification, Rev. 2.0 (PCI Express CEM 2.0)

PCI Express x16 Graphics 150W-ATX Specification, Rev. 1.0 (PCI Express 150W 1.0)

ISO 3744, Acoustics – Determination of Sound Power Levels of Noise Sources Using Sound Pressure – Engineering Method in an Essentially Free Field Over a Reflecting Plane

ISO 7779, Acoustics – Measurement of Airborne Noise Emitted by Information Technology and Telecommunications Equipment

Documentation Conventions

Capitalization

Some terms are capitalized to distinguish their definition in the context of this document from their common English meaning. Words not capitalized have their common English meaning. When terms such as "memory write" or "memory read" appear completely in lower case, they include all transactions of that type.

Register names and the names of fields and bits in registers and headers are presented with the first letter capitalized and the remainder in lower case.

Numbers and Number Bases

Hexadecimal numbers are written with a lower case "h" suffix, e.g., FFFh and 80h. Hexadecimal numbers larger than four digits are represented with a space dividing each group of four digits, as in 1E FFFF FFFFh. Binary numbers are written with a lower case "b" suffix, e.g., 1001b and 10b. Binary numbers larger than four digits are written with a space dividing each group of four digits, as in 1000 0101 0010b.

All other numbers are decimal.

Implementation Notes

Implementation Notes should not be considered to be part of this specification. They are included for clarification and illustration only.

Terms and Acronyms

AGP	Accelerated Graphics Port
AIC	Add-in card
CEM	Card Electromechanical
ECN	Engineering Change Notice
HE	High-End
Add-in card	A card that is plugged into a connector and mounted in a chassis slot
ATX	A system board form factor. Refer to the *ATX Specification, Rev. 2.2.*
ATX-based form factor	Refers to a form factor that does not exactly conform to the ATX specification, but uses the key features of ATX, such as the slot spacing, I/O panel definition, etc.
Evolutionary strategy	A strategy to develop the PCI Express connector and card form factors within today's chassis and system board form factor infrastructure constraints
PCIe	PCI Express

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1. Introduction

This specification addresses PCI Express cards with power and thermals greater than those supported by PCI Express CEM 2.0 and PCI Express 150W 1.0. Its purpose is to provide additional capabilities for PCI Express cards within the existing framework of an evolutionary strategy that is based on existing motherboard form factors. This specification is primarily designed to deliver additional electrical power to a PCI Express graphics card, or other add-in card, and to provide increased card volume for the management of thermals and acoustics.

This specification directly leverages PCI Express CEM 2.0 and PCI Express Base 2.0. Only differences from, or additions to, required areas for support of PCI Express 225 W/300 W High Power Cards are provided. This specification does not replace PCI Express 150W 1.0. It simply extends the existing usage model to support 225 W and 300 W high power cards. Therefore, this specification is applicable only when the application consumes more than 150 W of power. For PCI Express graphics add-in cards that are 150 W or lower, refer to PCI Express 150W 1.0.

This specification comprehends only the ATX form factor. The existence of other form factors, such as the BTX (*Balanced Technology Extended Interface Specification 1.0),* is recognized. Expanding this specification in the future to support other form factors may be considered when compelling needs arise. Additionally, this specification addresses only the single card scenario, just like PCI Express 150W 1.0. It is expected that, with tight cooperation between graphics card vendors or other high power card vendors and system OEMs, systems can scale and support multiple high power cards in a modular fashion.

This specification does not support the optional hot-plug functionality of PCI Express CEM 2.0.

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2. System Implementation

A PCI Express 225 W add-in card is defined as a card that exceeds PCI Express CEM 2.0 and PCI Express 150W 1.0 power delivery or thermal capability and, as such, consumes greater than 150 W with support for up to 225 W inclusive. This card may use the space of the adjacent expansion slot, thereby providing more volume for thermal solutions and components on the primary side of the card than the standard PCI Express add-in card which is constrained to the width of a single expansion slot. A system that supports a PCI Express 225 W add-in card is required to ensure that sufficient power and thermal support exists. For example, in an ATX system, the adjacent expansion slot may be left vacant allowing for 34.8 mm (1.37 inches) maximum clearance for the add-in card, as illustrated in Figure 2-1. The area on the add-in card that can utilize this height, as well as the restricted height of the secondary side, is not defined in this specification, rather it leverages the general PCI Express add-in card requirements for these dimensions.

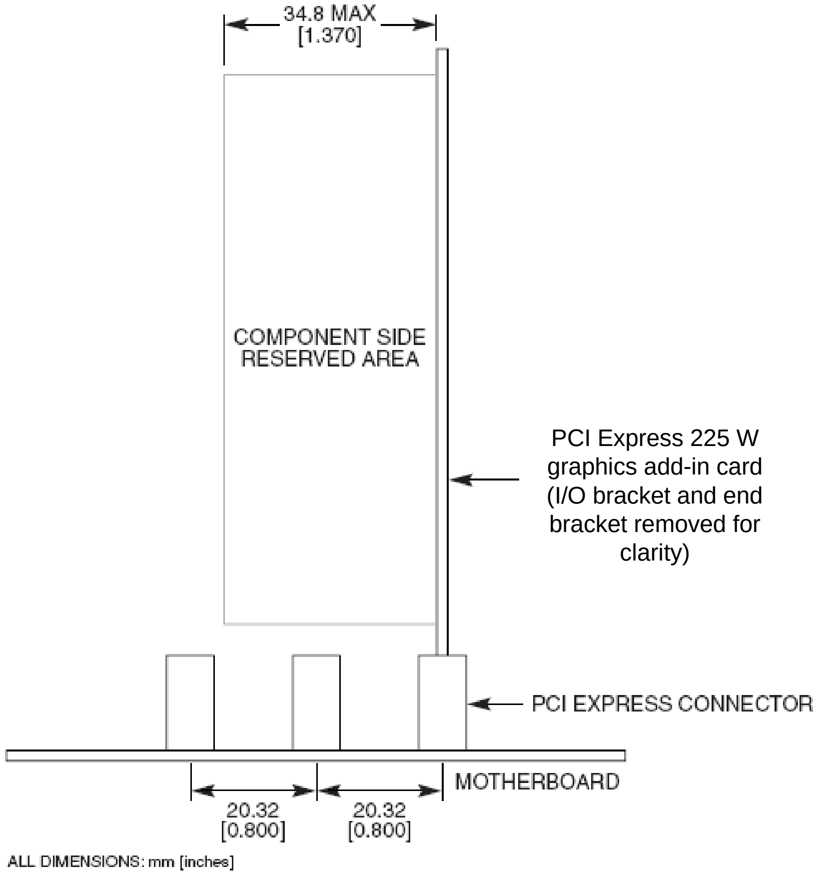

Figure 2-1: Example Orientation for PCI Express 225 W Add-in Card

A PCI Express 300 W add-in card is defined as a card that exceeds PCI Express CEM 2.0 and PCI Express 150W 1.0 power delivery or thermal capability and, as such, consumes greater than 225 W with support for up to 300 W inclusive. This card may use the space of the two adjacent expansion slots, thereby providing more volume for thermal solutions and components on the primary side of the card than the standard PCI Express add-in card which is constrained to the width of a single expansion slot. A system that supports a PCI Express 300 W add-in card is required to ensure that sufficient power and thermal support exists. As another example, in an ATX form factor system, the adjacent expansion slot may be left vacant allowing for 55.12 mm (2.17 inches) maximum clearance for the add-in card, as illustrated in Figure 2-2. The area on the add-in card that can utilize this height, as well as the restricted height of the secondary side, is not defined in this specification, rather it leverages the general PCI Express add-in card requirements for these dimensions.

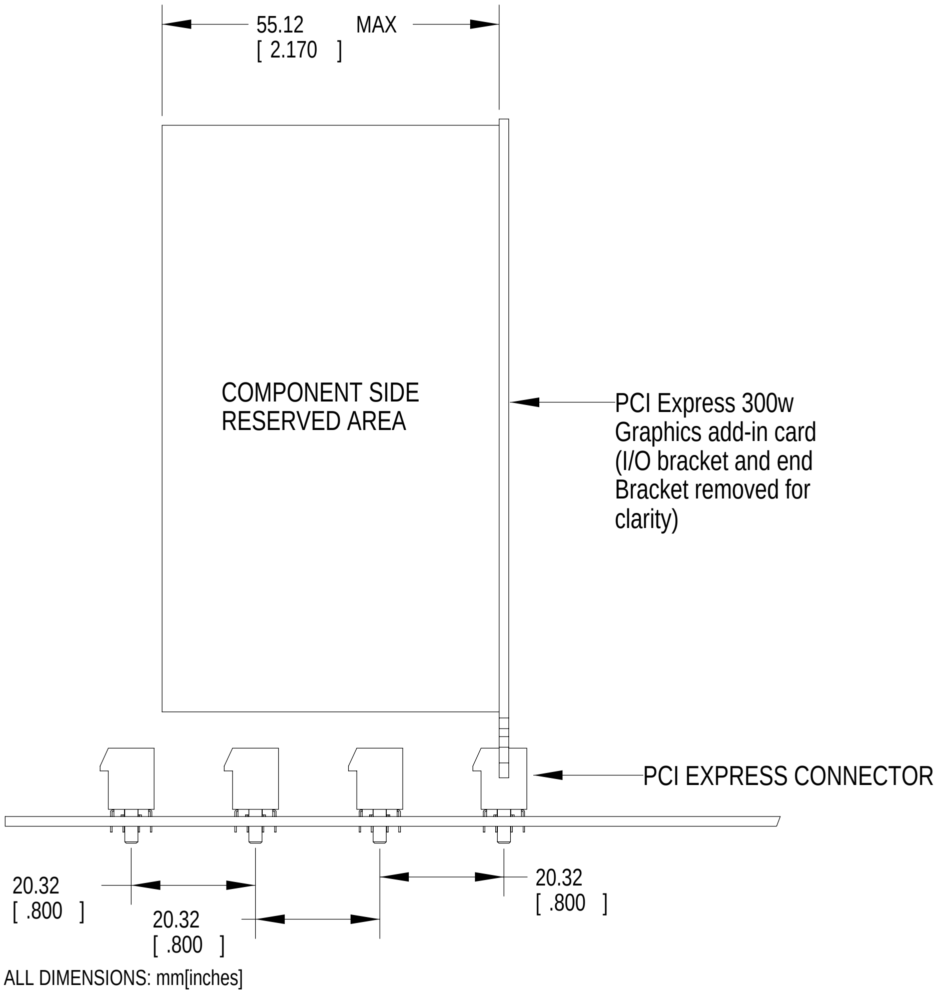

Figure 2-2: Example Orientation for PCI Express 300 W Cards

2.1. Usage Rules

A PCI Express 225 W/300 W add-in card can draw a maximum of 75 W through the standard x16 connector as specified in PCI Express CEM 2.0. Additional power, up to 150 W for the 225 W add-in card and up to 225 W for the 300 W add-in card, is provided through additional auxiliary connector(s) that is detailed in Chapter 4 of this specification.

2.2. System Power Delivery Requirements

A system that supports a PCI Express 225 W/300 W add-in card must deliver the +12 V to the standard x16 connector and the additional +12 V via additional auxiliary power supply connector(s), from the same or different rails in the power supply. This is up to the discretion of the system designer. For each 2 x 3 or 2 x 4 auxiliary power connector, the power supplied through the different pins must come from the same rail in the power supply. For add-in card requirements, refer to Chapter 3.

Table 2-1 provides the required specifications for the power supply rails available at the PCI Express x16 slot and auxiliary power connectors. The system designer is responsible for ensuring that the power delivered to the auxiliary connectors meets the specifications called out in Table 2-1.

Table 2-1: Power Supply Rail Requirements

Power Rail	75 W Slot	2 x 3 Connector	2 x 4 Connector	Remarks
+12V				
Voltage Tolerance	±8%	+5/-8%	+5/-8%	Max voltage variation between +12V inputs is 1.92 V
Supply Current	5.5 A	6.25 A	12.5 A	

IMPLEMENTATION NOTE

PCI Express Slot Requirements

The 75 W slot requirements are defined in PCI Express CEM 2.0. PCI Express 225 W/300 W add-in cards must be capable of accommodating the maximum voltage variation between the 75 W slot, 2 x 3 and 2 x 4 connector +12V inputs.

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3. Card Power

A PCI Express 225 W/300 W add-in card must adhere to strict power distribution, power-up, and power consumption requirements to ensure robust operation. Power must only be drawn using the three specified connectors: the standard PCI Express connector defined in PCI Express CEM 2.0, the 2 x 4 auxiliary power connector as defined in this specification, and the 2 x 3 auxiliary power connector as defined in PCI Express 150W 1.0.

It is necessary for a PCI Express 225 W/300 W add-in card to be seamlessly integrated with a 225 W/300 W capable system to ensure interoperability. To that end, it is required that the card be properly powered in the system. To guarantee proper operation and provide a safe user experience, the following power delivery requirements must be adhered to by a PCI Express 225 W/300 W add-in card:

- The +12V delivered from the standard x16 edge connector and the additional +12V(s) delivered via the dedicated 2 x 3 and/or 2 x 4 auxiliary power connector(s) must be treated as coming from independent separate system power supply rails.
- The different +12V input potentials from different connectors must not be electrically shorted at any point on a PCI Express 225 W/300 W add-in card.
- The power pins of a single 2 x 3 or 2 x 4 auxiliary power connector can be shorted together.
- No specific power sequencing between the slot, the 2 x 3 connector, and the 2 x 4 connector power can be assumed. A PCI Express 225 W/300 W add-in card must handle all possible combinations.
- A 300 W add-in card can receive power by the following methods:
  - 75 W from the x16 PCIe connector plus 150 W from a 2 x 4 connector plus 75 W from a 2 x 3 connector.
  - 75 W from the x16 PCIe connector plus 75 W from a first 2 x 3 connector, plus 75 W from a second 2 x 3 connector, plus 75 W from a third 2 x 3 connector. Note that this is NOT the preferred approach.
- A 225 W add-in card can receive power by one of the following methods:
  - 75 W from the x16 PCIe connector plus 150 W from a 2 x 4 connector.
  - 75W from the x16 PCIe connector plus 75 W from a 2 x 4 connector plus 75 W from a 2 x 3 connector.
  - 75W from the x16 connector plus 75 W from a first 2 x 3 connector plus 75 W from a second 2 x 3 connector.

IMPLEMENTATION NOTE

Auxiliary Power Connector Configurations for 225 W/300 W Add-in Cards

PCI Express 225 W/300 W add-in cards have a wide variety of power delivery configurations to choose from. This flexibility will lower the cost of migration as certain existing components (e.g., power supply units) can be reused.

IMPLEMENTATION NOTE

Safety Certifications

PCI Express 225 W/300 W add-in cards and capable systems must adhere to all applicable safety certifications (e.g., UL 240 VA) at all times.

3.1. Power-Up Sequencing

The following specified power-up sequencing process permits a PCI Express 225 W/300 W add-in card to sense if the auxiliary connectors are plugged in and identify the initial power draw limit. This methodology allows a PCI Express 225 W/300 W add-in card to circumvent the 25 W maximum power consumption that is required in PCI Express CEM 2.0 for a x16 add-in card prior to being enabled for higher power consumption via a Slot Power Limit message.

The system power-up sequencing follows the Slot Power Limit Control mechanism as defined in Chapter 6 of PCI Express Base 2.0. The power-up sequencing for a 225 W/300 W card is as follows:

- ❑ Immediately after system reset and before the card has determined which supplemental power connectors are attached, the card power is limited to 25 W which must be drawn from the PCI Express slot.
- ❑ At system power up, the permitted initial power draw depends on the auxiliary power connector configurations on the card and how many sense pins are detected. Table 3-1 to Table 3-5 enumerate the different possibilities.

- After system reset is released and the PCI Express link is up, the card will receive the Slot_Power_Limit message.
  - If the Slot_Power_Limit is bigger than or equal to the permitted initial power draw, the card can then draw power up to the Slot_Power_Limit in any order from the PCI Express edge connector, the 2 x 3 connector (if it exists), and the 2 x 4 connector (if it exists), subject to and limited to the individual power ratings of the respective connectors.
  - If the Slot_Power_Limit is smaller than the permitted initial power draw, the card can ignore the Slot_Power_Limit message and continue to draw the same amount of power as permitted at system power up time.

Table 3-1: PCI Express 300 W Card (With One 2 x 4 and One 2 x 3 Connector) Permitted Initial Power Draw

2 x 4 Sense0 Detected?	2 x 4 Sense1 Detected?	2 x3 Sense Detected?	Power Draw Permitted at System Power Up
N	N	N	25 W available from PCI Express edge connector
N	N	Y	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 3 connector
Y	N	N	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 4 connector
Y	N	Y	Total of 125 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 3 connector 50 W available from 2 x 4 connector
Y	Y	N	Total of 125 W is available: 25 W available from PCI Express edge connector 100 W available from 2 x 4 connector
Y	Y	Y	Total of 175 W is available: 25 W available from PCI Express edge connector 100 W available from 2 x 4 connector 50 W available from 2 x 3 connector

Table 3-2: PCI Express 300W Card (With Three 2 x 3 Connectors) Permitted Initial Power Draw

First 2 x 3 Sense Detected?	Second 2 x 3 Sense Detected?	Third 2 x 3 Sense Detected?	Power Draw Permitted at System Power Up
N	N	N	25 W available from PCI Express edge connector
N	N	Y	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 3 connector
N	Y	N	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 3 connector
Y	N	N	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 3 connector
Y	N	Y	Total of 125 W is available: 25 W available from PCI Express edge connector 50 W available from the first 2 x 3 connector 50 W available from the third 2 x 3 connector
Y	Y	N	Total of 125 W is available: 25 W available from PCI Express edge connector 50 W available from the first 2 x 3 connector 50 W available from the second 2 x 3 connector
N	Y	Y	Total of 125 W is available: 25 W available from PCI Express edge connector 50 W available from the second2 x 3 connector 50 W available from the third 2 x 3 connector
Y	Y	Y	Total of 175 W is available: 25 W available from PCI Express edge connector 50 W available from the first 2 x 3 connector 50 W available from the second 2 x 3 connector 50 W available from the third 2 x 3 connector

Table 3-3: PCI Express 225 W Card (With One 2 x 4 Connector) Permitted Initial Power Draw

2 x 4 Sense0 Detected?	2 x 4 Sense1 Detected?	Power Draw Permitted at System Power Up
N	N	25 W available from PCI Express edge connector
Y	N	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 4 connector
Y	Y	Total of 125 W is available: 25 W available from PCI Express edge connector 100 W available from 2 x 4 connector

Table 3-4: PCI Express 225 W Card (With Two 2 x 3 Connectors) Permitted Initial Power Draw

First 2 x 3 Sense Detected?	Second 2x3 Sense Detected?	Power Draw Permitted at System Power Up
N	N	25 W available from PCI Express edge connector
N	Y	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from second 2 x 3 connector
Y	N	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from first 2 x 3 connector
Y	Y	Total of 125 W is available: 25 W available from PCI Express edge connector 50 W available from first 2 x 3 connector 50 W available from second 2 x 3 connector

Table 3-5: PCI Express 225 W Card (With One 2 x 3 and One 2 x 4 Connector) Permitted Initial Power Draw

2x4 Sense0 Detected?	2x4 Sense1 Detected?	2x3 Sense Detected?	Power Draw Permitted at System Power Up
N	N	N	25 W available from PCI Express edge connector
N	N	Y	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 3 connector
Y	N	N	Total of 75 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 4 connector
Y	N	Y	Total of 125 W is available: 25 W available from PCI Express edge connector 50 W available from 2 x 3 connector 50 W available from 2 x 4 connector
Y	Y	N	Total of 125 W is available: 25 W available from PCI Express edge connector 100 W available from 2 x 4 connector
Y	Y	Y	Total of 175 W is available: 25 W available from PCI Express edge connector 100 W available from 2 x 4 connector 50 W available from 2 x 3 connector

For a 225 W/300 W add-in card, if the auxiliary power connector(s) is not populated in such a way that results in the full 225 W/300 W power being available to the graphics add-in card, any graphics operation and actual display to a connected output device, whether VGA or otherwise, is not guaranteed and is implementation dependent. However, it is preferred that an implementation supplied warning text message is displayed to alert the user of the configuration issue.

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4. PCI Express 2 x 4 Auxiliary Power Connector Definition

This chapter defines the PCI Express 2 x 4 auxiliary power connector and cable assembly.

For backward compatibility, the 2 x 3 auxiliary power connector plug can be inserted into the 2 x 4 auxiliary power connector receptacle. The 2 x 4 receptacle is keyed such that the 2 x 3 connector plug needs to be properly aligned to plug in. Based on the sense codings in the 2 x 4 plug, a 225 W/300 W card with a 2 x 4 receptacle can detect if a 2 x 4 or a 2 x 3 plug is inserted. The 225 W/300 W card can then draw the appropriate power correspondingly.

The 2 x 4 auxiliary power connector plug should not be inserted into the 2 x 3 auxiliary power connector receptacle and is physically prevented from doing so. A dongle should be used for this purpose.

Figures 4-1 to 4-3 depict the described auxiliary power connector mating scenarios.

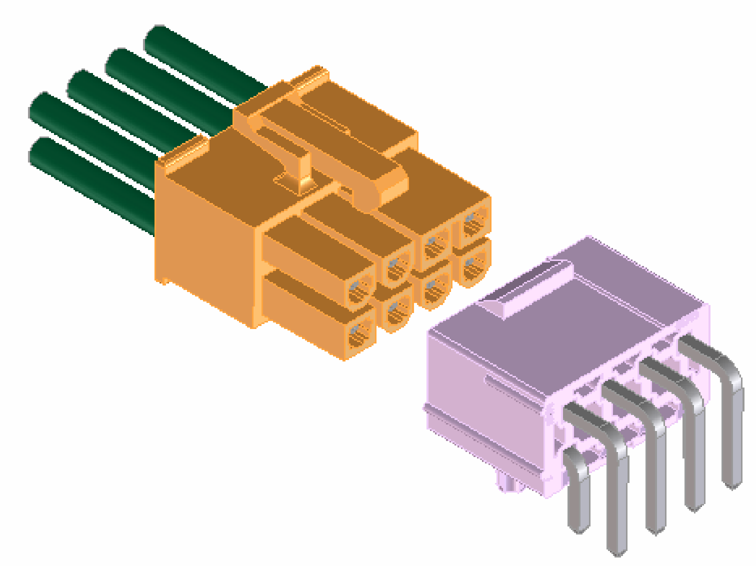

Figure 4-1: 2 x 4 Plug Mating with a 2 x 4 Receptacle

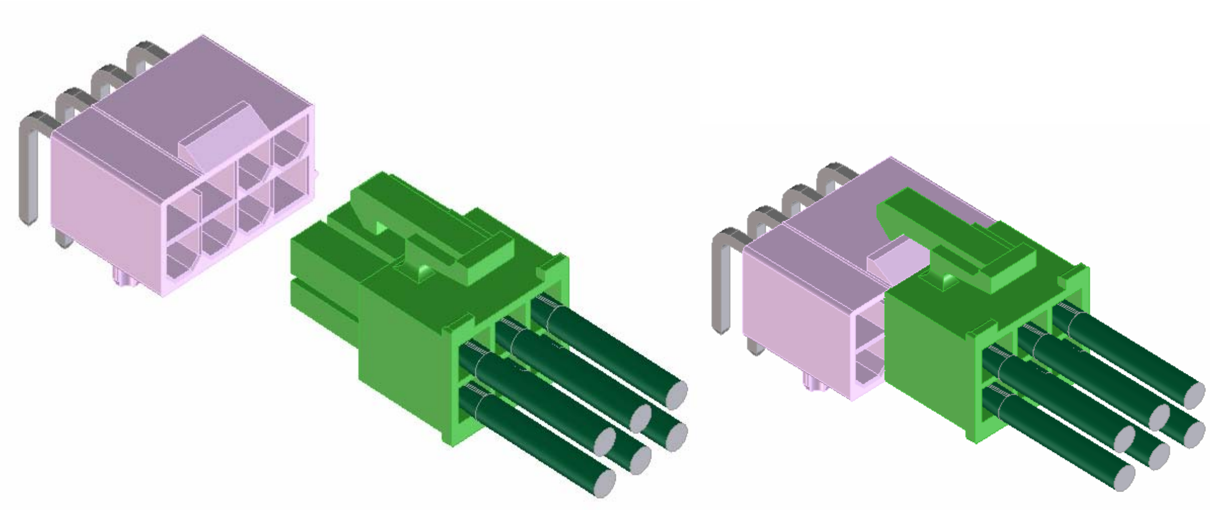

Figure 4-2: 2 x 3 Plug Mating with a 2 x 4 Receptacle

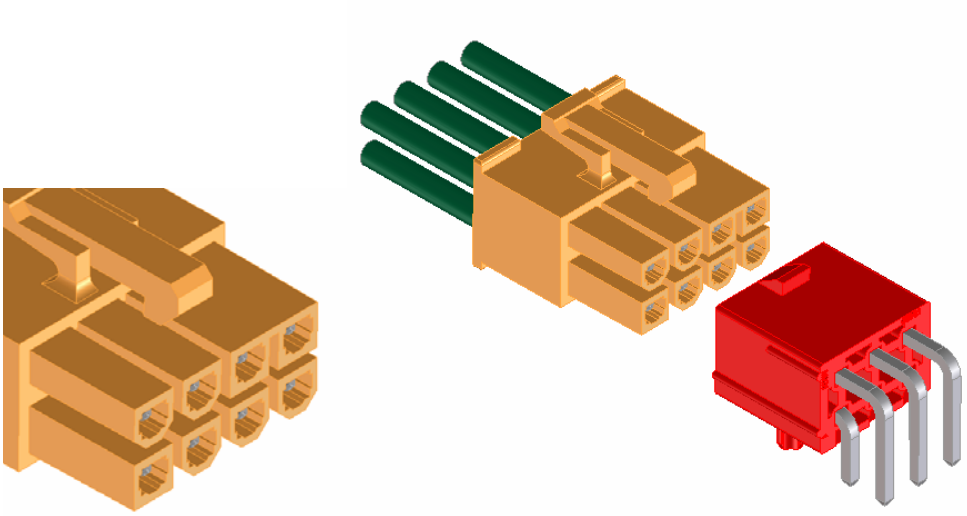

Figure 4-3: 2 x 4 Plug is Physically Prevented From Mating with a 2 x 3 Receptacle

4.1. 2 x 4 Auxiliary Power Connector Performance Requirements

The auxiliary power connector performance requirements are as follows:

- **Current Rating:** 7.0 amperes per pin/position maximum to a 30 °C T-Rise above ambient temperature conditions at 12 VDC with all eight contacts energized
- **Mated Connector Retention:** 30.00 N minimum when plug pulled axially

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IMPLEMENTATION NOTE

Auxiliary Power Connector Current Rating

System integrators should ensure that the contacts used in auxiliary power connector are of the correct rating to meet the 7.0 amperes requirement. Appropriate derating practices should be used.

4.2. 2 x 4 Receptacle

4.2.1. Connector Drawing

Figure 4-4 shows the details of a 2 x 4 (eight-position), right-angle (R/A) through-hole connector.

Notes:

- Housing Material: Thermoplastic
- Pin Contact Base Material: Brass Alloy or equivalent
- Pin Contact Plating: Sn Alloy
- An alignment rib is defined (detail A) to help guide the mating with a 2 x 3 plug.
- Though not defined in this specification, a vertical receptacle, in which the mating cable plug is perpenticular to the add-in card, is also allowed. Add-in card manufacturers can work with their connector vendors to enable such a connector.
- All dimensions are in mm [inches].

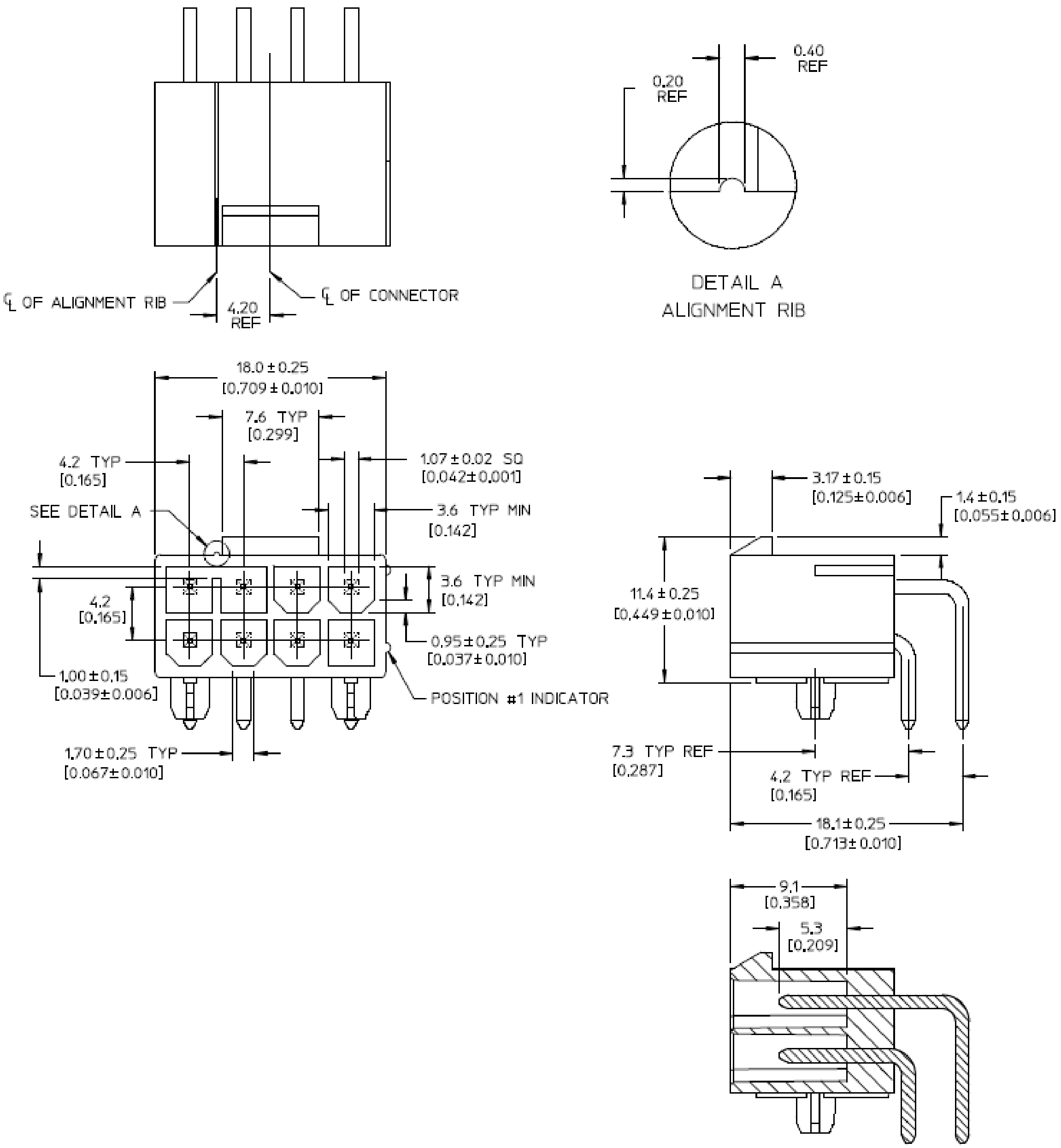

Figure 4-4: 2 x 4 R/A Thru-Hole Receptacle Drawing

4.2.2. PCB Footprint

Figure 4-5 shows the recommended PCB footprint for the 2 x 4 R/A receptacle.

Note: All dimensions are in mm [inches].

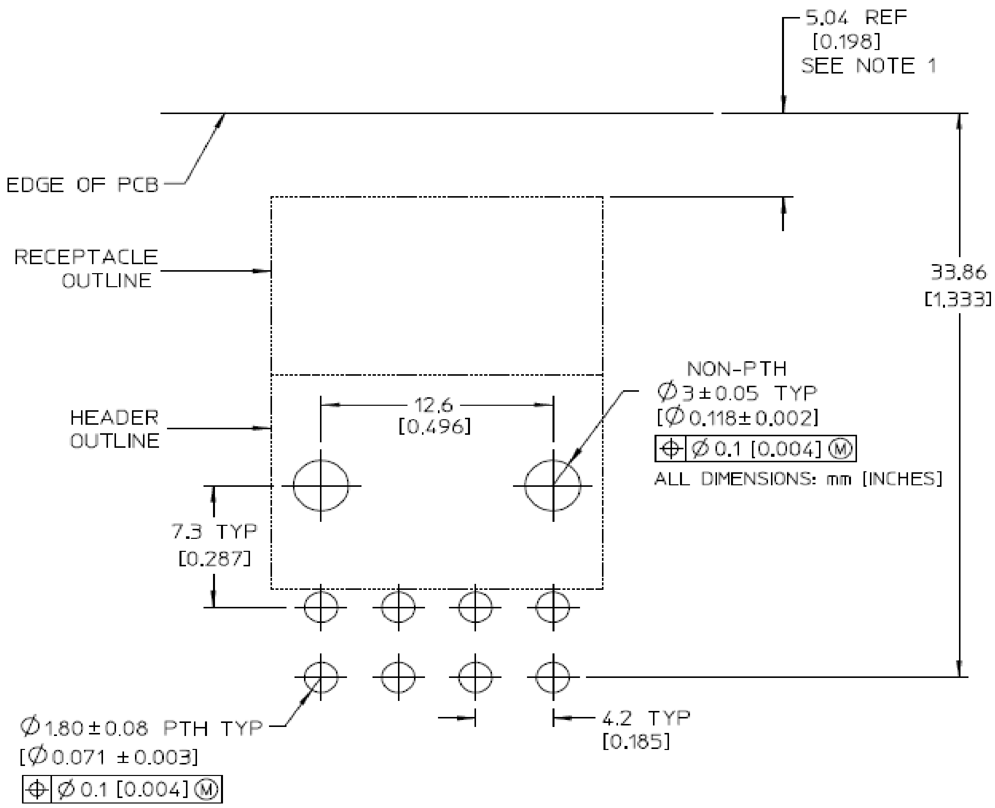

Figure 4-5: 2 x 4 R/A Thru-Hole Recptacle Recommended PCB Footprint

4.3. Cable Assembly

Figure 4-6 shows the cable plug connector housing.

Note: All dimensions are in mm [inches].

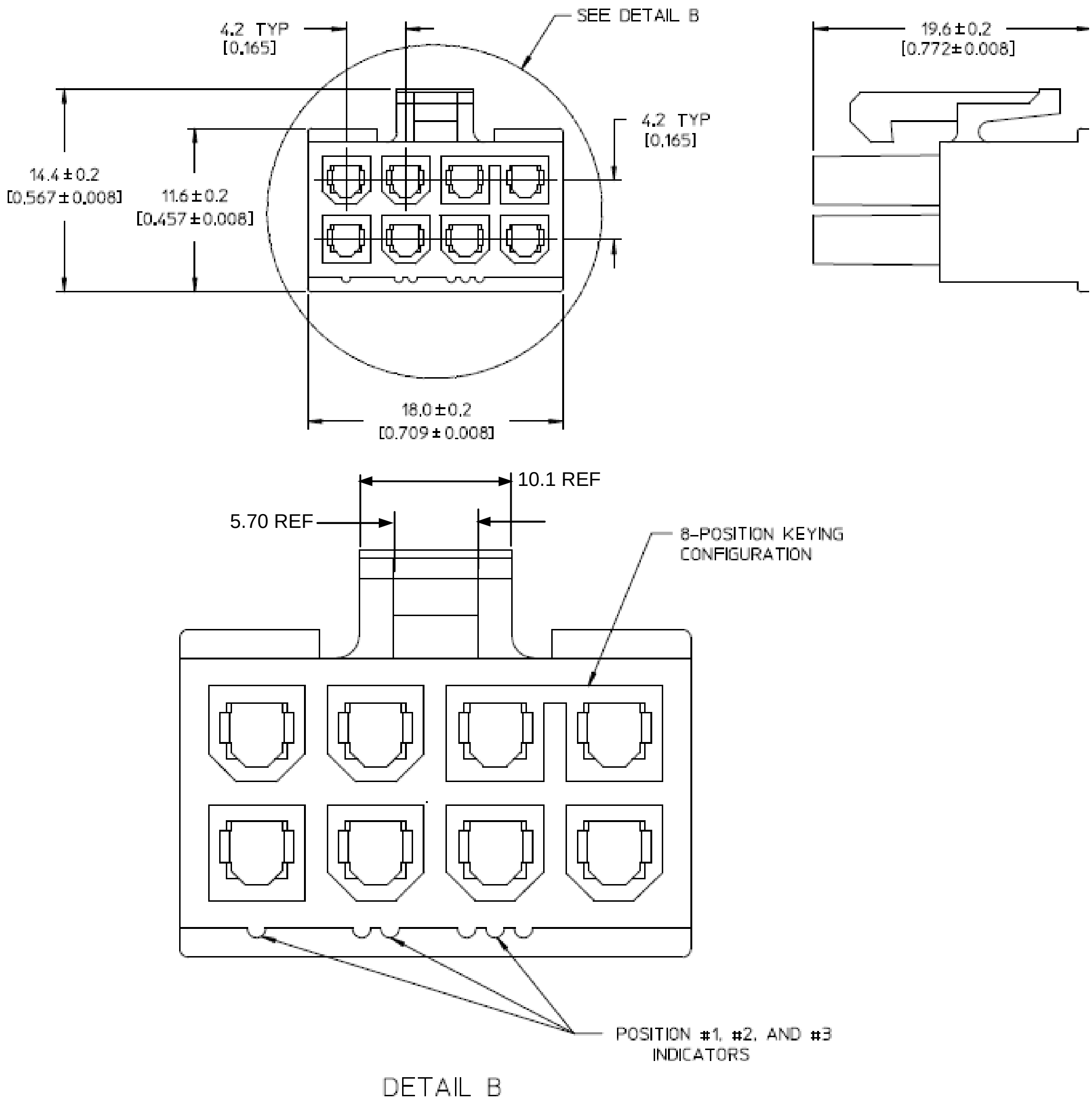

Figure 4-6: Cable Plug Connector Housing

Cable Assembly Contact and Housing Details:

- ❑ Housing Material: Thermoplastic; special polarization per Figure 4-6.
- ❑ Pin Contact Base Material: Brass alloy or equivalent
- ❑ Pin Contact Plating: Sn alloy

Wire Details:

- ❑ Wire Size: 18 AWG
- ❑ Cable Bend Radius: 1xR minimum

IMPLEMENTATION NOTE

Modular Plug Connector Assembly

A 2x4 plug connector can be designed with a 2x3 plug module and a 2x1 plug module to form a 2x4 modular plug connector such that it can be plugged into a 2x4 or 2x3 recptacle. Cable assembly vendors should design the Latch Lock Hook and Release Handle with the dimensions noted in Figure 4-7 to ensure that the connector locks securely when plugged into a 2x4 or a 2x3 recpetacle. The rest of the dimensions are same as shown in Figure 4.6.

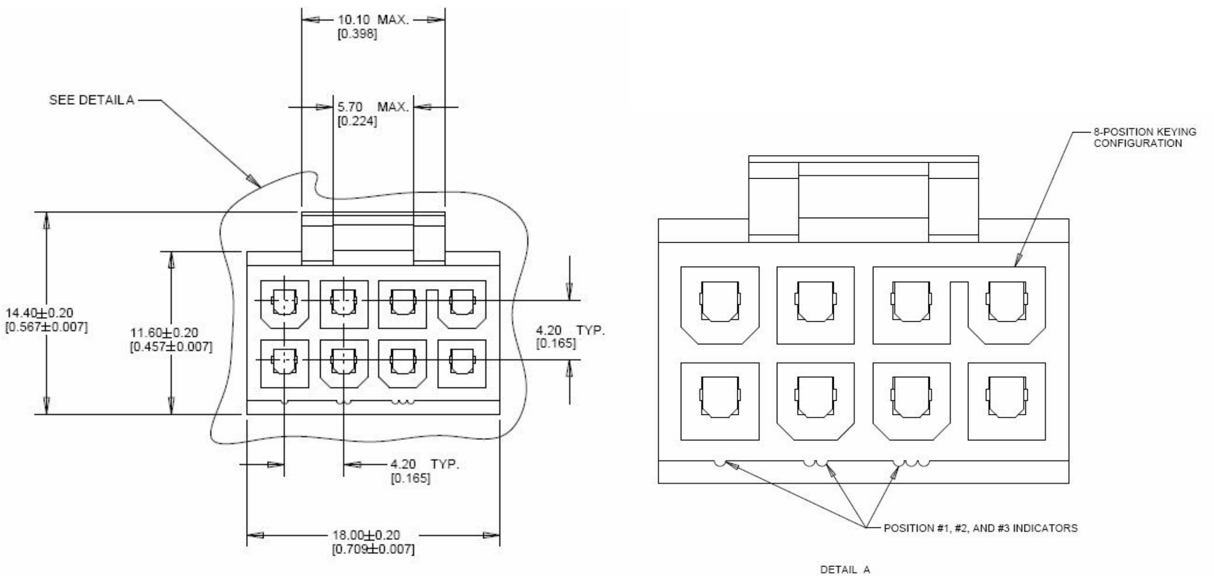

Figure 4-7: Modular Plug Connector Housing (All dimensions in mm [inches])

4.4. Connector Mating-Unmating Keep-Out Area (Latch Lock Release)

The connector mating-unmating keep-out area is specified in Figure 4-8.

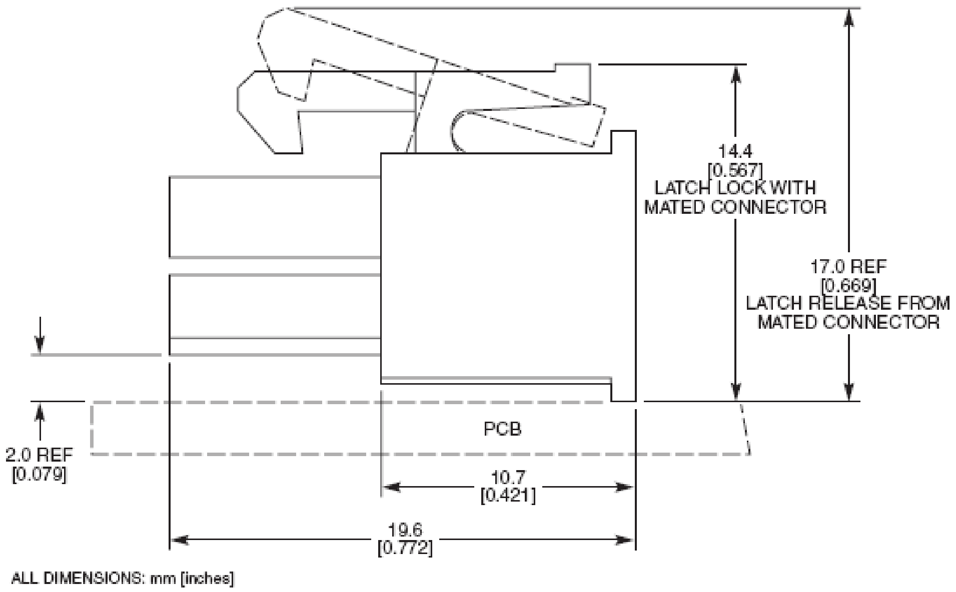

Figure 4-8: Connector Mating-Unmating Keep-Out Area (Latch Lock Release)

4.5. 2 x 4 Auxiliary Power Connector System Pin Assignment

Figure 4-9 and Figure 4-10 show the pin-out for the 2 x 4 auxiliary power connector.

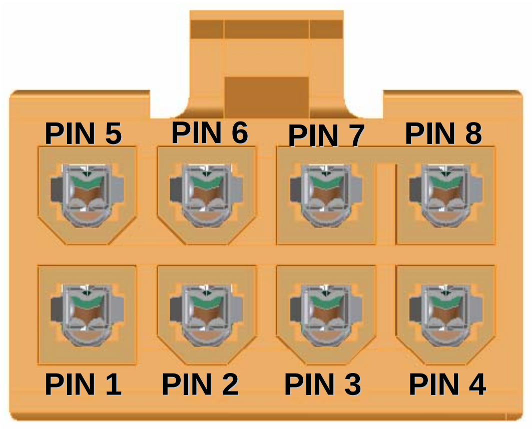

Figure 4-9: 2 x 4 Auxiliary Power Connector Plug Side Pin-out

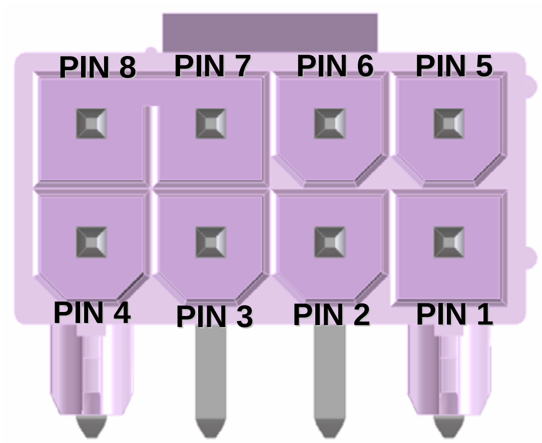

Figure 4-10: 2 x 4 Auxiliary Power Connector Receptacle Side Pin-out

Table 4-1 and Table 4-2 show the 2 x 4 pin-out assignments. A 225 W/300 W card with a 2 x 4 auxiliary power connector receptacle, decodes the sense coding to determine how much power to draw from the 2 x 4 auxiliary power connector.

Table 4-1: 2 x 4 Auxiliary Power Connector pin-out assignment

Pin	Signal
1	+12 V
2	+12 V
3	+12 V
4	Sense1
5	Ground
6	Sense0
7	Ground
8	Ground

Table 4-2: Sense Pins Decoding by a Graphics Card

Sense1	Sense0	Comment
Ground	Ground	A 2 x 4 auxiliary power connector is plugged into the card. The graphics card can draw up to150 W from the auxiliary power connector.
Ground	Open	Reserved
Open	Ground	A 2 x 3 auxiliary power connector is plugged into the card. The graphics card can only draw up to 75 W from the auxiliary power connector.
Open	Open	No auxiliary power connector is plugged in.

For a sense pin that needs to be grounded, it must be connected to ground either directly in the power supply or via a jumper to an adjacent ground pin in the connector. The sense pins are used by a PCI Express 225 W/300 W card to detect how much power to draw from the auxiliary power connector.

A 2 x 4 auxiliary power connector plug from the power supply unit must not use the 75 W sense coding (Sense1=Open and Sense0=Ground) to avoid end-user confusion.

For informational purposes, Figure 4-11 shows the 2 x 3 auxiliary power connector pin-out as defined in PCI Express 150W. Table 4-3 shows how the pins are mapped when a 2 x 3 plug is inserted into a 2 x 4 receptacle.

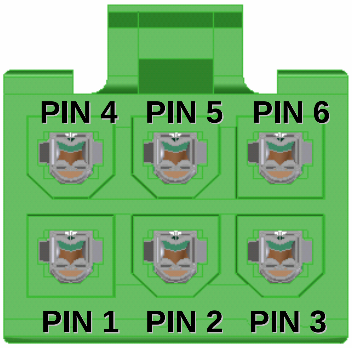

Figure 4-11: 2 x 3 Auxiliary Power Connector Pin-out as Defined in PCI Express 150W 1.0

Table 4-3: 2 x 3 Plug to 2 x 4 Receptacle Pin Mapping

2 x 3 Plug	2 x 4 Receptacle	Signal
1	1	+12 V
2	2	+12 V
3	3	+12 V
NA	4	Sense1
4	5	Ground
5	6	Sense0
6	7	Ground
NA	8	Ground

4.6. Additional Considerations

Table 4-4 lists the additional requirements for the PCI Express 2 x 4 auxiliary power connector.

Table 4-4: Additional Requirements

Parameter	Procedure	Requirement
Flammability	UL94V-1 minimum	Material certification or certificate of compliance required with each lot to satisfy the Underwriters Laboratories follow-up service requirements
Lead-free soldering		Connector must be compatible with lead free soldering process.
Connector Color		Color of the connector should be black. Exceptions will be made for color coding schemes that call for a different color of this connector.

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5. Mechanical Specification

The PCI Express 225 W/300 W add-in card form factor is based on the add-in card form factor specified in PCI Express CEM 2.0 (Chapter 6). The primary exception is the restricted component height on the primary side of the card and the card keep-out areas.

5.1. PCI Express 225 W/300 W Add-in Card Dimensions

The form factor dimensions for a PCI Express 225 W/300 W add-in card are shown in Table 5-1 and Figure 5-1. The component height limits are illustrated in Figure 5-1 and Figure 5-2.

Table 5-1: PCI Express 225 W/300 W Add-in Card Dimensions

Power Level		Height	Length	Component Side Height Restriction
225 W	Standard height, full length cards	111.15 mm (4.376 inches) maximum	312.00 mm (12.283 inches) maximum	34.80 mm (1.37 inches) maximum
300 W	Standard height, full length cards	111.15 mm (4.376 inches) maximum	312.00 mm (12.283 inches) maximum	55.12 mm (2.17 inches) maximum

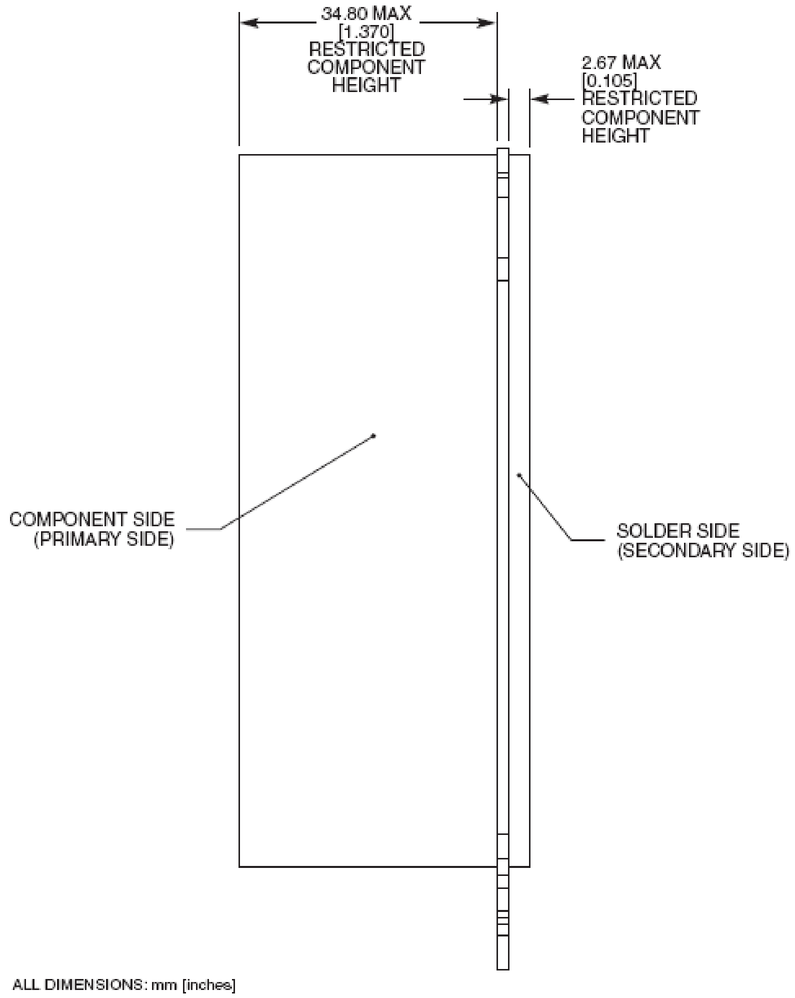


Figure 5-1: PCI Express 225 W Add-in Card Dimensional Drawing

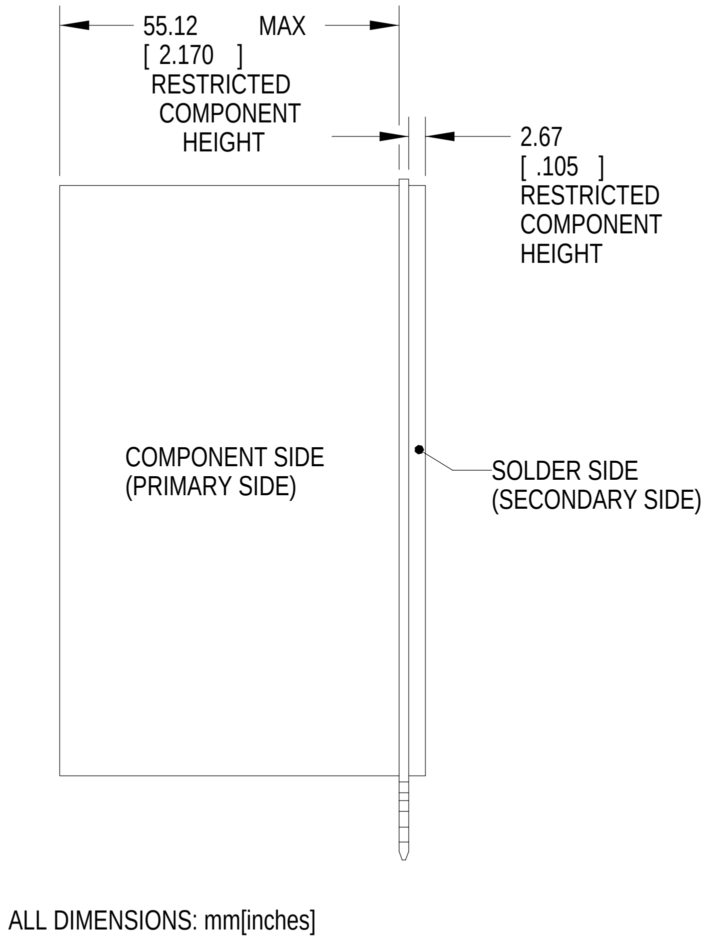


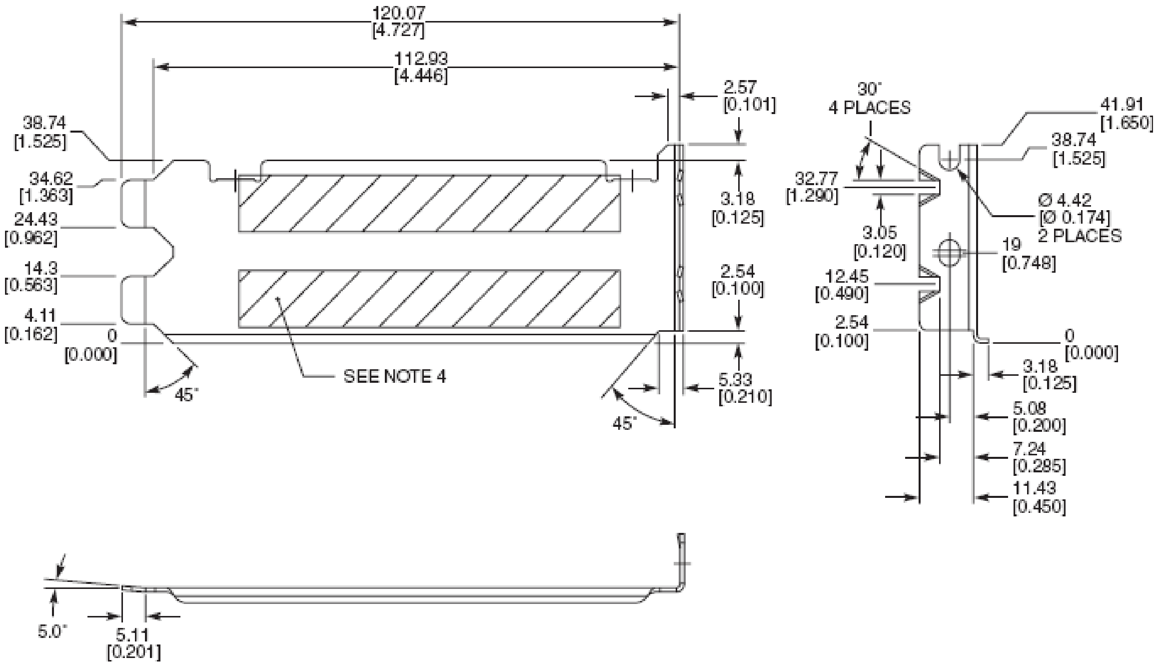
Figure 5-2: PCI Express 300 W Add-in Card Dimensional Drawing

5.2. Add-in Card Mounting

To enable maximum leverage with PCI Express CEM 2.0 (Chapter 6), the majority of all form factor dimensions are identical. The only exception is the additional spacing of the restricted component height on the primary side of the card (refer to Section 5.1). A PCI Express 225 W/300 W add-in card may utilize a two/three slot I/O bracket to accommodate adequate thermal management.

Figure 5-3 is a detailed drawing of a two-slot I/O bracket design. Figure 5-4 is an isometric view of the two-slot I/O bracket with an area for graphics card venting. Figure 5-3 is a detailed drawing of a three-slot I/O bracket design.

The size and number of any holes in the bracket should follow proper EMI and thermal design guidelines. The brackets should be mechanically strong enough to survive system-level shock and vibration.



NOTES:
1. MATERIAL: 0.034 THK (20 GA) LOW CARBON STEEL, ZINC PLATED
2. TOLERANCES: +/- 0.254 [0.010] UNLESS OTHERWISE SPECIFIED
3. ALL DIMENSIONS: mm [inches]
4. CROSS HATCH AREA INDICATES I/O CONNECTOR/THERMAL VENTING WINDOW

Figure 5-3: Detailed Two-Slot I/O Bracket Design

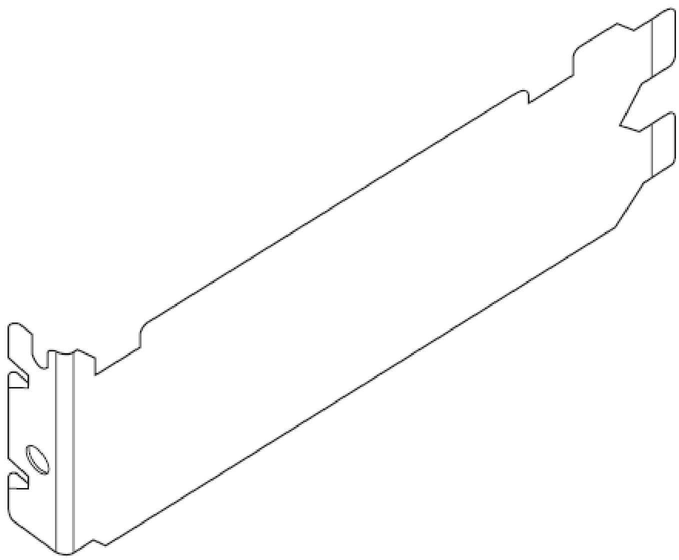


Figure 5-4: Two-Slot I/O Bracket Example (Isometric View)

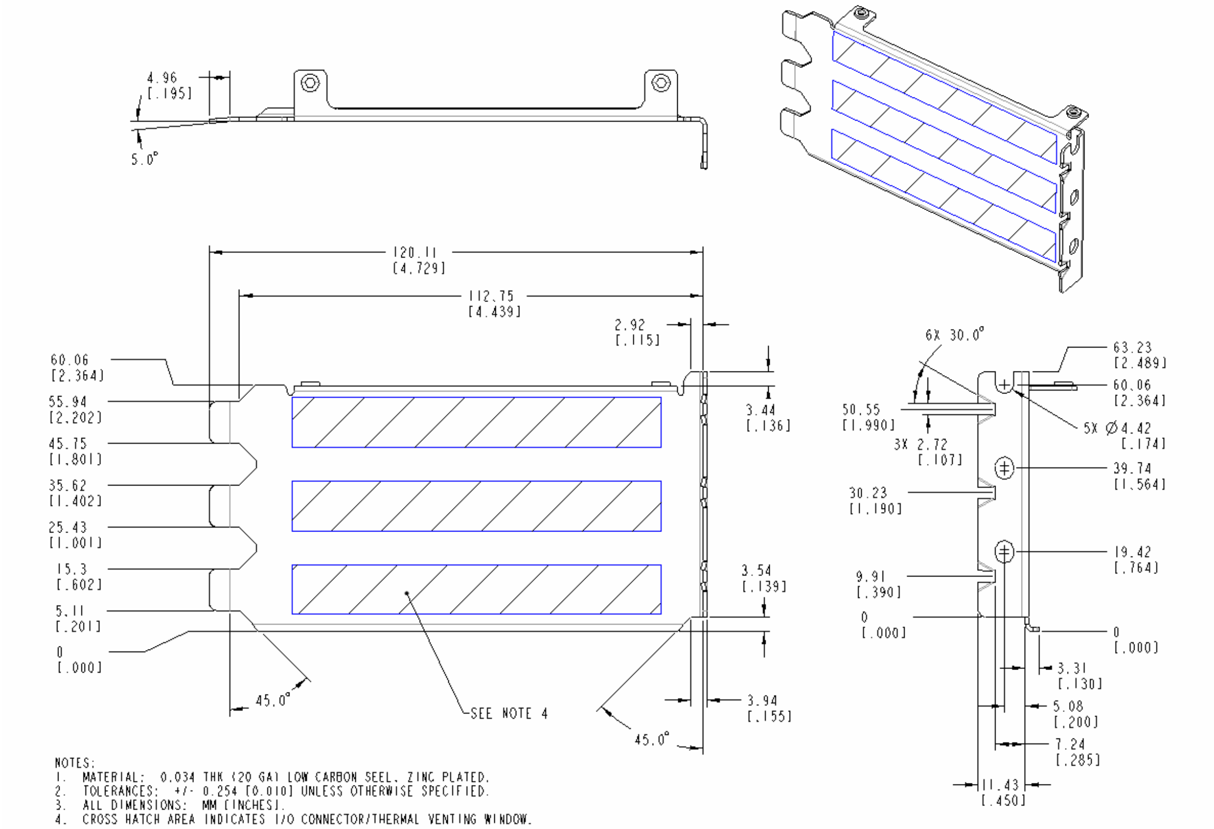


Figure 5-5: Detailed Three-Slot I/O Bracket Design

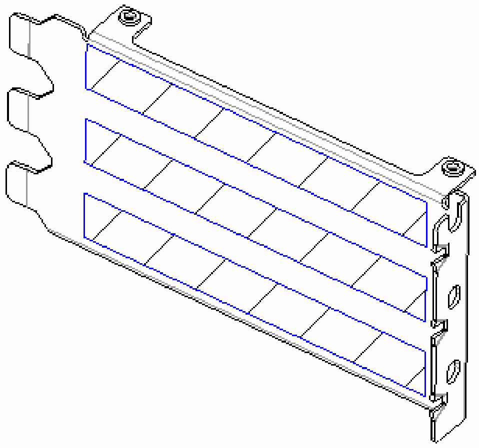


Figure 5-6: Three-Slot I/O Bracket Example (Isometric View)

5.3. Card Retention

This specification defines keepouts and features on the PCI Express 225 W/300 W card to be used for card retention (see Section 5.5). Detailed retention mechanism design, however, is considered implementation specific and it is up to system OEMs to work with card vendors.

The following guidelines should be observed when designing retention mechanism for the PCI Express 225 W/300 W cards:

- The use of the "hockey stick" feature alone is unlikely to be sufficient because of the high card mass allowed in this specification (1.5 kg maximum). The use of the keepout area (as defined in Section 5.5) to hold the card in place is strongly recommended. This mechanism may be necessary to prevent exessive deformation of the card during shock and vibration.
- The bracket is part of the card retention mechanism. It should have sufficient mechanical strength to withstand system-level shock and vibration. Deformation of card brackets has been one of the major failure mechanisms in the past.
- All cards shall be enabled for a full-length add-in card retainer as shown in PCI Express CEM 2.0 Figure 6-6. Partial length cards shall have means of being extended to full length and equipped with the retainer. The card features used for extending partial length cards to full length are the card vendor's option; they may include component keep-outs and holes similar to those shown in PCI ExpressCEM 2.0, Figure 6-1.
- All cards shall be enabled for a full-length stiffener to minimize card flexure during dynamic events. When included, the stiffener should be located within the card component keep-in volume as defined in Figures 5-1, 5-2, and 5-7. Implementation details are the card vendor's option.

5.4. Card Mass Limit

A PCI Express 225 W/300 W card shall not exceed 1.5 kilograms in mass. To support such a mass, attentions must be paid to bracket, chassis strengths, and retention mechanism designs. Card manufacturers should make efforts to minimize the card mass.

5.5. Board Keepout

A PCI Express 225 W/300 W card shall provide a component and trace keepout area as defined in Figure 5-7. The 130 mm region at the top edge is for system to support the card in the Z-direction by holding the card in place. Mating connectors are not allowed to extend above the top edge of the card in this region. Outside of the specified 130 mm area, mating connectors are allowed to extend beyond the edge of the card.

All the card outline and keepouts that are not dimensioned follow PCI Express CEM 2.0, Chapter 6.

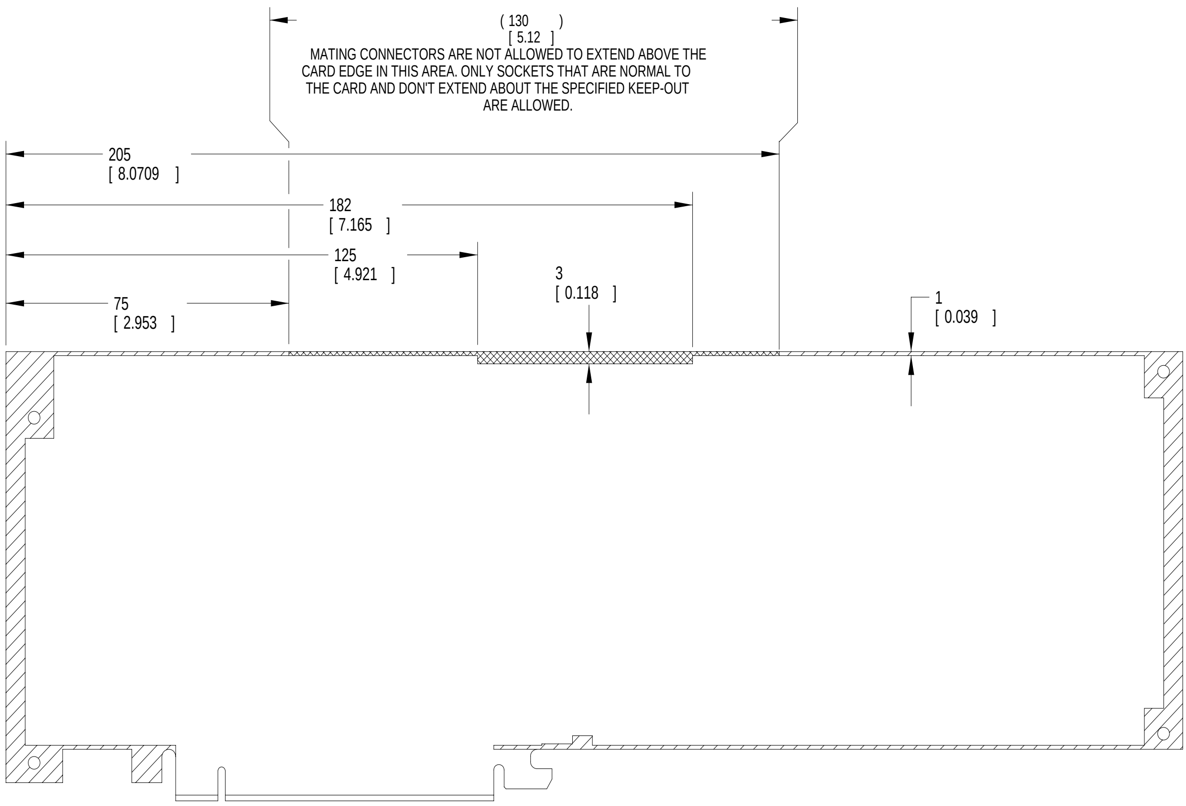


Figure 5-7: Keepout Area in mm [inches]

6

6. Thermal and Acoustic Management

Increasing card power has a corresponding impact on the thermal (for example, inlet temperature and airflow) and acoustic management solutions of the PCI Express 225 W/300 W high power add-in cards and the platforms that support them. To ensure robust system operation and reliability, the high power cards and systems must work together to dissipate the additional thermal load the card puts on the system.

6.1. Inlet temperature

Inlet temperature is defined as the average temperature at the card thermal solution's fan inlet. Since the fan location may vary for different cards, engineering judgment should be utilized to determine the exact locations for the inlet temperature sensors placement. Figure 6-1 illustrates an example showing the temperature sensor placement at the thermal solution inlet; one may consider the averaged temperature measured by the different sensors as the inlet temperature.

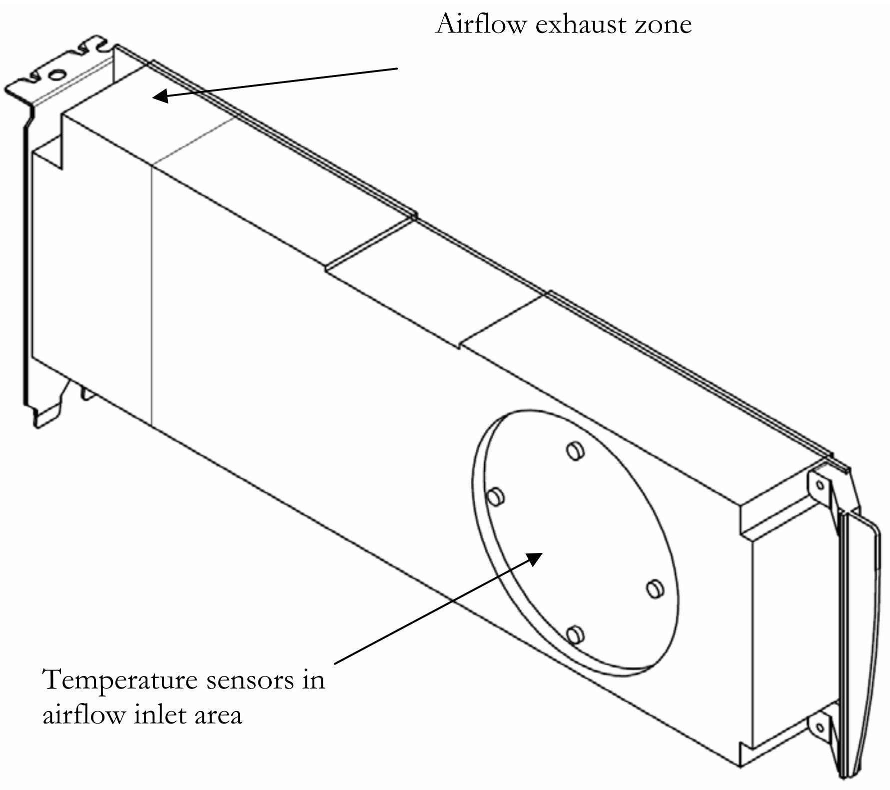


Figure 6-1: Example of a High Power Card Showing Temperature Sensor Placements at the Thermal Solution Inlet

The procedure described in Section 6.2 should be used as a guideline for characterizing the high power add-in card. The add-in card inlet temperature should be controlled at 45 °C for both 300 W and 225 W cards.

For cards with a forced convection thermal solution, the rear bracket shall include vents for airflow exhaust to the outside of the system. Any airflow exhaust inside the system should be located at the rear end of the card as shown in Figure 6-1. It is recommended that any airflow exhaust inside the system should be located within 2.0 inches of the rear bracket.

6.2. Card Thermal Characterization Procedure

The following method should be used to carry out thermal characterization of 225 W/300 W high power add-in card.

- The measurement should be carried out on a 225 W/300 W high power add-in card with an open bench test setup system as shown in Figure 6-2 to Figure 6-4. Figure 6-2 illustrates a setup to test a card that occupies two slots. Note that dimensions in Figure 6-2 apply to other fixture versions shown in Figure 6-3 and Figure 6-4, except as noted otherwise. The fixture may be made of ¼ inch thick polycarbonate plastics, simulating full-length adjacent cards and a standard rear chassis panel.

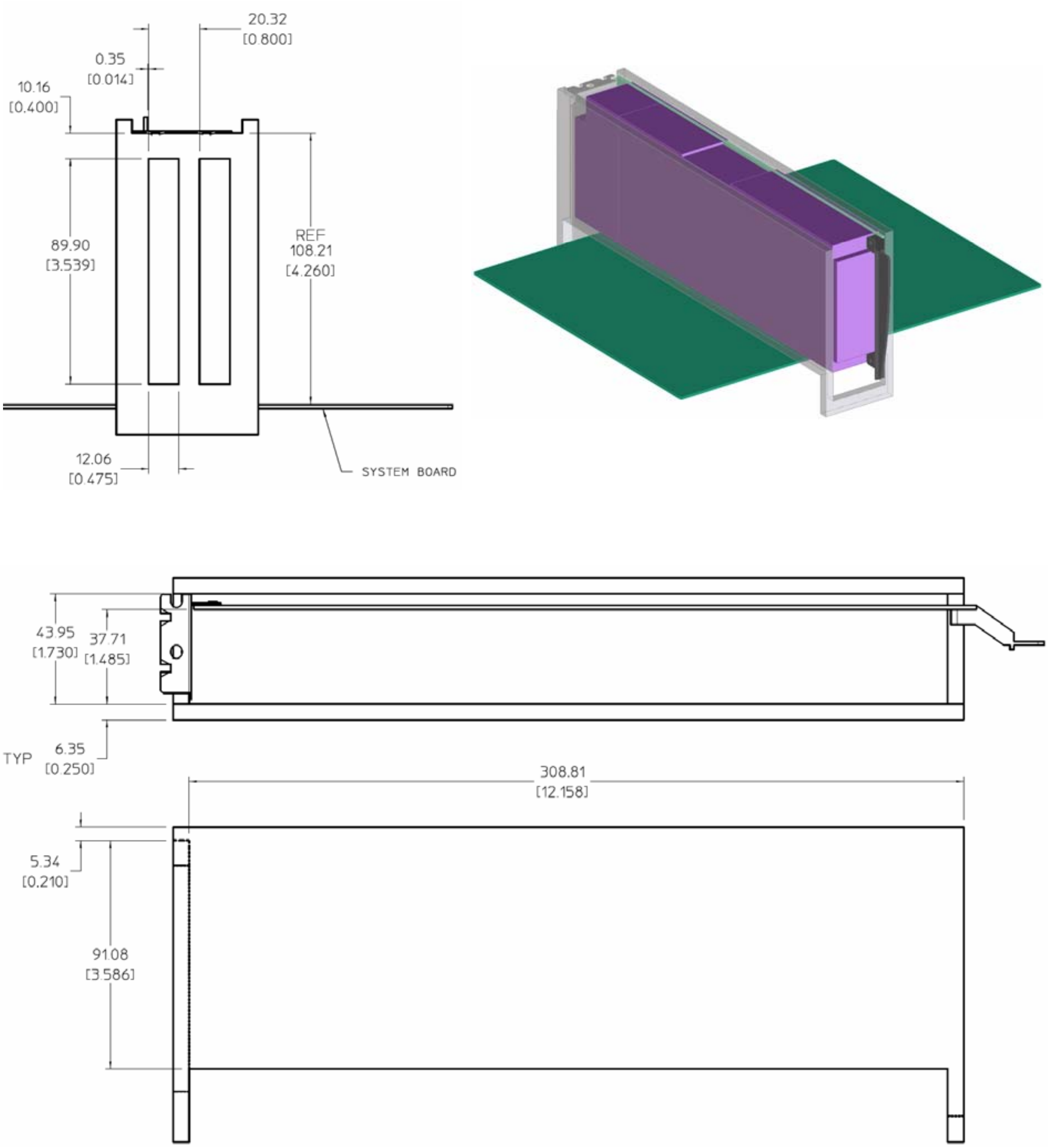


Figure 6-2: Thermal Characterization Fixture – Two-slot Version

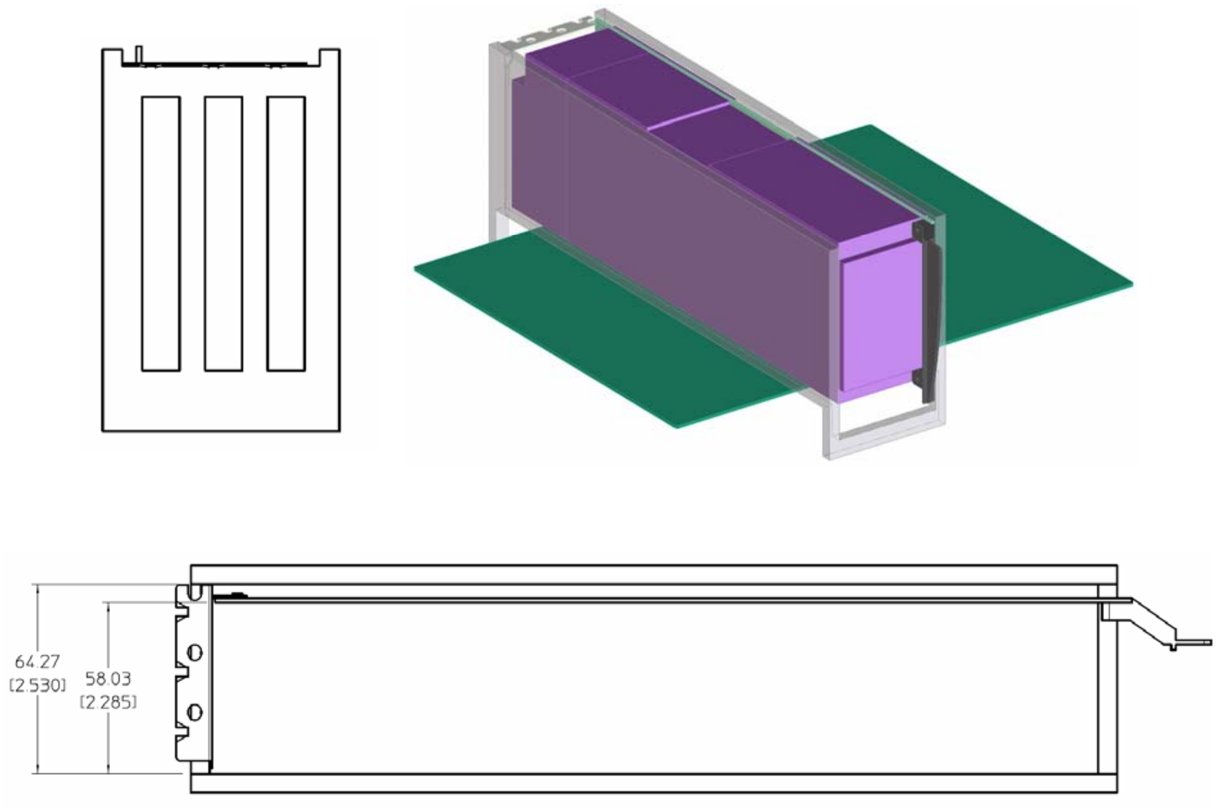


Figure 6-3: Thermal Characterization Fixture – Three-slot Version

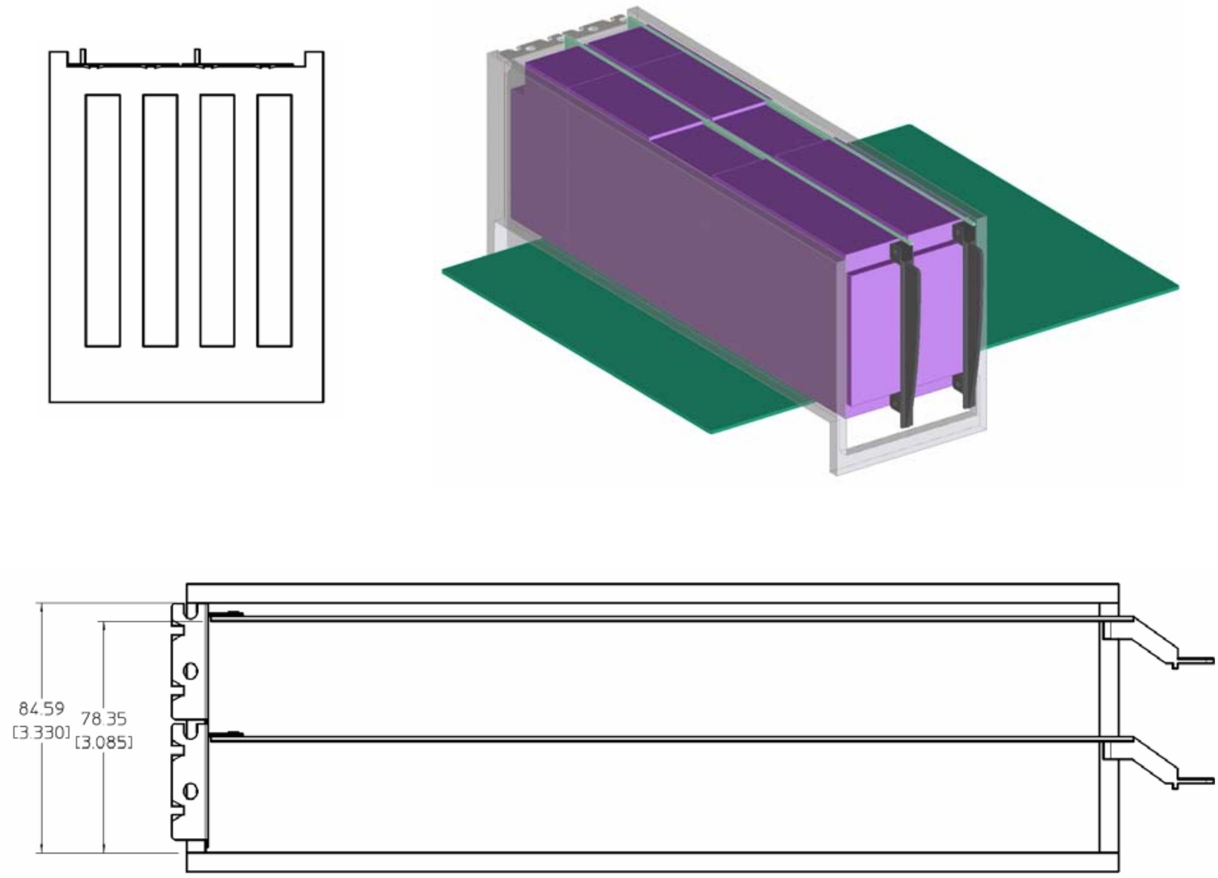


Figure 6-4: Thermal Characterization Fixture – Tandem Two-slot Version

Specific test procedures are described below:

- ❑ Install the card under test in one of the test setups or fixtures shown in Figures 6-2 to 6-4 according to the card volumetrics.
- ❑ Place the test setup in a thermal chamber and adjust the chamber temperature such that the card's inlet temperature is 45 °C (for both 300 W and 225 W cards).
- ❑ Thermal characteristic measurements listed below should be carried out with the card in idle and full power states. The "idle" and "full power" states are defined by the add-in card vendor and are to be recorded as condition under which the thermal characterization is performed.
    - Critical component temperatures
    - Critical temperature limits
    - Inlet temperature
    - Exhaust temperature
    - Fan speed

Airflow (CFM) exiting the rear I/O bracket is of great interest and value to system builders. When requested, card vendors should work directly with system builders on the details of how to measure the CFM.

6.3. Acoustic Management

The acoustic emission of a system is increasingly important for computer systems. This is becoming more challenging with higher power systems. The acoustic noise sources in a system are typically the cooling fans, the power supply fan, the graphics card fan, the hard drive, and the optical drives.

The high power card manufacturers, the chassis designers, and the system integrators must work closely together to deliver a reasonable solution, such that the end user experience is not impacted.

6.3.1. Background and Scope

The acoustic noise generated by high power PCI Express cards can be a significant contributor to overall system noise and, in fact, can be the loudest single component in the computer system. Card and system vendors will need to work together to make sure the acoustic emissions meet end-user requirements, contractual requirements, and/or government-mandated acoustic standards.

This specification does not define acoustic requirements for card compliance. Instead, this specification lists a few general guidelines and defines a standardized method for measuring card acoustics. This standardized method is intended to help system and card vendors to understand acoustic performance of the cards and to work together more efficiently and reduce acoustic emissions.

6.3.2. Card Acoustic Characterization Procedure

The following method uses an industry-standard method, ISO 3744, to measure acoustic emissions and adapts it to the particular constraints associated with PCI Express cards. This method uses the "idle" and "full power" fan speed data gathered in the Card Thermal Characterization Procedure (Section 6.2).

- ❑ Measurement and test setup should be as defined in ISO 3744, *Acoustics – Determination of Sound Power Levels of Noise Sources Using Sound Pressure – Engineering Method in an Essentially Free Field Over a Reflecting Plane*.
- ❑ Place the card in the acoustic chamber by itself, in free air, without the system board or any other system components. The card under test should be suspended by some type of "bungee cords" to avoid any fixturing effect on acoustics;. The detailed implementation of the "bungee cords" is up to each card manufacturer.
- ❑ It is not necessary to fully power or operate the card. Instead, it is necessary to operate only the fan; this can be accomplished with an external power source and fan control circuit.

- Measure and/or calculate the following acoustic emissions at both the “idle” and “full power” fan speeds.
    1. sound pressure, L_{PA}
    2. sound power, L_{WA}
    3. 1/3-octave acoustic spectral content

Notes:

1. Any equipment used for fan power and control must be located outside the acoustic chamber or be sufficiently quiet so as not to contribute to the acoustic measurements.
2. The particular circuit (i.e., waveform) used to control the fan may have a significant effect on the acoustic results, especially at low fan speeds.

6.3.3. Acoustic Recommendations and Guidelines

In addition to minimizing the overall acoustic levels, the following points should be considered:

- The acoustic emissions should not include any prominent tones.
- Certain frequencies are more objectionable to humans than others.
- The card’s fan(s) should be dynamically controlled to minimize noise over the complete range of expected operational and environmental conditions.
- The card’s fan(s) should be controlled such that there are no abrupt changes or noticeable oscillations in acoustic levels or quality.
- The chassis should be designed so as to minimize coupling of vibrations and acoustic noise from the card to the chassis.
- The card should be designed so as to minimize coupling of vibrations from the card's fan to the card.