



**PC/104 Embedded Consortium**

*www.pc104.org*

***EBX™ and EBX Express™  
Specification***

**(Embedded Board, eXpandable)**

**Version 3.01**

**June 14, 2012**

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# REVISION HISTORY

## **Version 2.0 — January 13, 2005:**

- a. Initial release from PC/104 Embedded Consortium.
- b. Adopted from EBX Specification 1.1.
- c. Removed company-specific information.
- d. Added references to the PC/104 Embedded Consortium.
- e. Updated address information for the PC/104 Embedded Consortium.
- f. Updated rev number.
- g. Corrected section numbering.
- h. Removed reference to IEEE P996 specification.
- i. Updated contact information for reference documents.
- j. Removed reference to recommended power connector.
- k. Increased area for the power connector.
- l. Included the third PC/104, PC/104-*Plus*, and PCI-104 I/O area which overhangs the EBX board near the ISA connector.

## **Version 3.0 — October 23, 2008:**

- a. Added PCI/104-Express to create EBX Express
- b. Added standoff mechanical drawing
- c. Changed PCMCIA location to PC Card and included ExpressCard

## **Version 3.01 — June 14, 2012:**

- a. Corrected dimension of PCIe/104 connector alignment pin in Figure 4 EBX Express Detailed Mechanical Drawing

# TABLE OF CONTENTS

1.	INTRODUCTION .....	1
2.	REFERENCE DOCUMENTS.....	3
3.	DIMENSIONS AND MOUNTING HOLES.....	4
3.1.	Dimensions.....	4
3.2.	Mounting Holes.....	4
3.3.	PC/104 Architecture Expansion Stack Location .....	4
3.3.1.	Expansion Bus Connectors .....	4
3.3.2.	Stackthrough Bus Option.....	5
3.3.3.	PC/104- <i>Plus</i> Keep Out Area.....	5
4.	VERTICAL CLEARANCE ZONES.....	6
4.1.	Zone A: Memory Expansion .....	7
4.2.	Zone B: Power Connector .....	7
4.3.	Zone C: Video I/O (Option) .....	7
4.4.	Zone D: Miscellaneous Primary Side Components .....	7
4.5.	Zone E: General Purpose I/O, Tall Region .....	7
4.6.	Zone F: PC/104 Architecture Expansion Stack Location .....	7
4.7.	Zone G: PC/104 Architecture I/O Areas .....	7
4.8.	Zone H: Tall CPU (Option).....	8
4.9.	Zone I: PC Card/Express Card Slot (Option).....	8
4.10.	Zone J: General Purpose I/O, Low Profile Region .....	8
4.11.	Secondary Side Components.....	8
4.12.	Board Thickness .....	8
5.	POWER CONNECTOR AND POWER REQUIREMENTS.....	9
5.1.	Power Requirements.....	9
6.	EBX and EBX Express Form Factor .....	10
6.1.	EBX Detailed Mechanical Dimensions.....	10
6.2.	EBX Express Detailed Mechanical Dimensions .....	11
6.3.	EBX and EBX Express Component Zones, Tall CPU Option.....	12
6.4.	EBX and EBX Express Component Zones, PC Card Slot Option.....	13
7.	CONNECTORS.....	14
7.1.	PCI Express Connector .....	14
7.1.1.	Part Number .....	14
7.1.2.	ASP-129637-03 or equivalent (Top Connector) Mechanical Drawings.....	15
7.1.3.	ASP-129646-03 or equivalent (Bottom Connector) Mechanical Drawings .....	16
7.1.4.	PCI Express Connector Specifications .....	17
7.2.	PCI Connector .....	19
7.2.1.	PCI Connector Mechanical.....	19
7.2.2.	PCI Connector Specifications .....	20
7.3.	8-Bit and 16-Bit ISA Connector.....	21
7.3.1.	8-Bit and 16-Bit ISA Connector Mechanical.....	21
7.3.2.	8-Bit and 16-Bit ISA Connector Specification .....	22
8.	STANDOFF.....	23
8.1.	Standoff Mechanical.....	23

## TABLE OF FIGURES

Figure 1 Example of EBX SBC Layout.....	1
Figure 2 PC/104 Bus Options .....	5
Figure 3 EBX Detailed Mechanical Drawing.....	10
Figure 4 EBX Express Detailed Mechanical Drawing .....	11
Figure 5 EBX and EBX Express Component Zones, Tall CPU Option.....	12
Figure 6 EBX and EBX Express Component Zones, PC Card Option .....	13
Figure 7: Top Half and Bottom Half of Connector A Shown with Pick-and-Place Adapters.....	14
Figure 8: ASP-129637-03 or equivalent Mechanical Drawings.....	15
Figure 9: ASP-129646-03 or equivalent Mechanical Drawings.....	16
Figure 10 PCI Connector Mechanical Drawing.....	19
Figure 11 PCI Connector Shroud Mechanical Drawing .....	19
Figure 12 ISA Connector Mechanical Drawing .....	21
Figure 13 Standoff Mechanical Dimensions.....	23

## TABLE OF TABLES

Table 1 EBX Vertical Clearance Zones.....	6
Table 2 Power Connector Voltage Requirements.....	9

## 1. INTRODUCTION

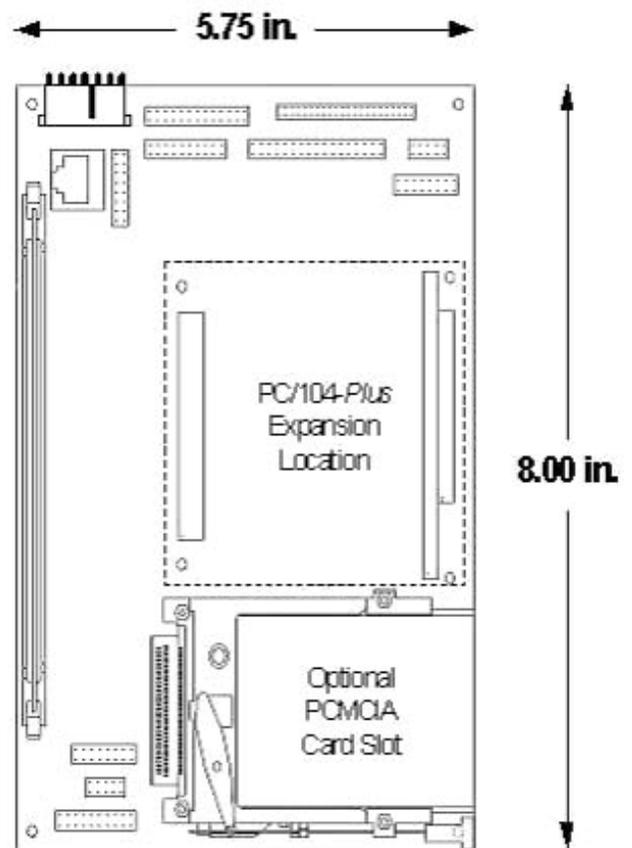
Until now, embedded system designers had to choose among off-the-shelf backplane solutions, desktop motherboards, and proprietary designs. Size and power consumption constraints hampered finding the right solutions for embedded deployment. Consequently, OEMs wanting to purchase off-the-shelf equipment to shorten time-to-market were often forced to develop proprietary solutions.

Standards are important to the embedded systems market. Popular backplane form-factors — including VME, CompactPCI™, Multibus™, STD32®, and passive backplane ISA — are well documented mechanical and electrical standards. Desktop motherboards, which fit certain high-end embedded applications, also follow standards such as Baby AT, LPX, ATX, and the NLX standard. All these standards allow vendors and OEMs to create products that are easily packaged in enclosures and readily expanded via open interfaces. However, none of these backplane-based standards satisfy the unique space, power, and reliability constraints of small embedded systems.

**Figure 1 Example of EBX SBC Layout**

The availability of an embedded single-board computer (SBC) standard will ensure that embedded computing solutions can be designed into space constrained environments with off-the-shelf components. The embedded market constantly demands improvements in functionality and performance, while at the same time seeking size and cost reduction. The “Embedded Board, eXpandable” (EBX) standard creates the opportunity for solutions which fit the requirements of embedded system OEMs; takes advantage of trends in the embedded computing market; and offers the convenience, flexibility, risk reduction, and scalability of multi-sourced off-the-shelf products.

The “Embedded Board, eXpandable” (EBX) standard is the result of a collaboration between industry leaders to unify the embedded computing industry on a small footprint embedded single-board computer standard. The EBX combines a standard footprint with open interfaces. The EBX form-factor is small enough for deeply embedded applications, yet large enough to contain the functions of a full embedded computer system: CPU, memory,



mass storage interfaces, display controller, serial/parallel ports, and other system functions.

The EBX form factor boasts highly flexible and adaptable system expansion, allowing easy and modular addition of functions not contained in standard product offerings. This EBX system expansion is based on popular existing industry standards — PC/104™, PC/104-Plus™, PCI-104™, PCI/104-Express™, PCIe/104™, PC Card, and ExpressCard. PC/104 places the ISA bus on compact 3.6” x 3.8” modules with self-stacking capability. PC/104-Plus adds the power of a PCI bus to PC/104 while retaining the basic form-factor. PCI-104 removes the ISA bus from the PC/104-Plus to allow more board space for more components and connectors while maintaining a high-speed PCI expansion bus. PCI/104-Express adds high speed PCI Express to PCI-104 and PCIe/104 removes the PCI bus leaving only PCI Express.

For further expansion flexibility, a PC Card or ExpressCard area offers access to cards from the mobile and handheld computing markets.

The EBX standard integrates all these off-the-shelf standards into a highly embeddable SBC form-factor. EBX supports the stackable PC/104, PC/104-Plus, PCI-104, PCI/104-Express, and PCIe/104 giving it access to the wide variety of embedded system oriented expansion modules from hundreds of companies worldwide. PC Card brings the advantages of the latest portable and mobile system expansion technologies to embedded applications. Additionally, the EBX PCI and PCI Express infrastructure offer true processor independence and high performance standards-based system expansion.

EBX compliant boards have a form-factor large enough to implement a powerful SBC capable of hosting today’s advanced operating systems, yet small enough to fit in the tight spaces of deeply embedded applications. This creates an exciting new opportunity for embedded system OEMs to standardize their designs and take advantage of off-the-shelf modules.

The EBX standard is open to continuing technology advancements, since it is both processor and payload independent. It creates opportunity for economies of scale in chassis, power supply, and peripheral devices. It defines how products interoperate by providing mechanical rules for mandatory features and recommended zones for flexible I/O options. These attributes combine to make EBX the right choice for embedded computing.

The adoption of the standard by the PC/104 Embedded Consortium brings stability to the embedded board market and offers OEMs assurance that a wide range of products will be available from multiple sources — now and in the future. The EBX specification is freely available to all interested companies, and may be used without licenses or royalties. For further technical information on the EBX standard, please contact:

**PC/104 Embedded Consortium**

E-mail: [info@pc104.org](mailto:info@pc104.org)

Website: [www.pc104.org](http://www.pc104.org)

## 2. REFERENCE DOCUMENTS

This EBX and EBX Express specification makes reference to, and is based on, the current versions of the following specifications:

**PC/104, PC/104-Plus, PCI-104, and PCI/104-Express and PCIe/104:**  
PC/104 Embedded Consortium, [www.pc104.org](http://www.pc104.org)

**PCI Local Bus Version 2.2:**  
PCI Special Interest Group <mailto:>, [www.pcisig.com](http://www.pcisig.com)

**PC Card and ExpressCard Standards:**  
PCMCIA, [www.pcmcia.org](http://www.pcmcia.org)

Technical references about the PCI and ISA buses themselves are available from numerous sources, including RTC Books ([www.rtcbooks.com](http://www.rtcbooks.com)), Mindshare ([www.mindshare.com](http://www.mindshare.com)), and others.

- "ISA and EISA Theory and Operation" by Edward Solari
- "ISA System Architecture" by MindShare, Inc.
- "PCI and PCI-X Hardware and Software (Architecture and Design Library)" by Edward Solari
- "PCI System Architecture" by MindShare, Inc.

### 3. DIMENSIONS AND MOUNTING HOLES

Figure 3 and Figure 4 provide the detailed dimensions and mounting hole locations of the EBX form-factor. With the exception of the four holes labeled “B”, all dimensions indicated for board size and mounting holes are *mandatory*.

#### 3.1. Dimensions

The dimensions of an EBX form factor board are 5.75 x 8.00 inches (146 by 203 mm).

#### 3.2. Mounting Holes

Eight mounting holes are specified. These are marked “A” in Figure 3. Four of these are located in the corners of the EBX form-factor and four others correspond to the mounting locations common to all of the PC/104 Specifications. It is recommended that all eight defined mounting holes be used to provide rugged attachment of the board to its enclosure or parent assembly.

#### 3.3. PC/104 Architecture Expansion Stack Location

The EBX form factor provides a module stack location as defined by the PC/104, PC/104-*Plus*, PCI-104, PCI/104-Express, and PCIe/104 specifications. This location accepts PCIe/104 (PCI Express), PCI/104-Express (PCI Express and PCI), PCI-104 (PCI), PC/104-*Plus* (PCI and ISA), or PC/104 (ISA) expansion modules. Figure 3 defines the precise location of this area, the PC/104 ISA, PCI, and PCI Express expansion connectors, and the associated mounting holes. Refer to the PCI/104-Express, PC/104-*Plus* and PC/104 specifications for information on the full electrical and mechanical specifications associated with this location.

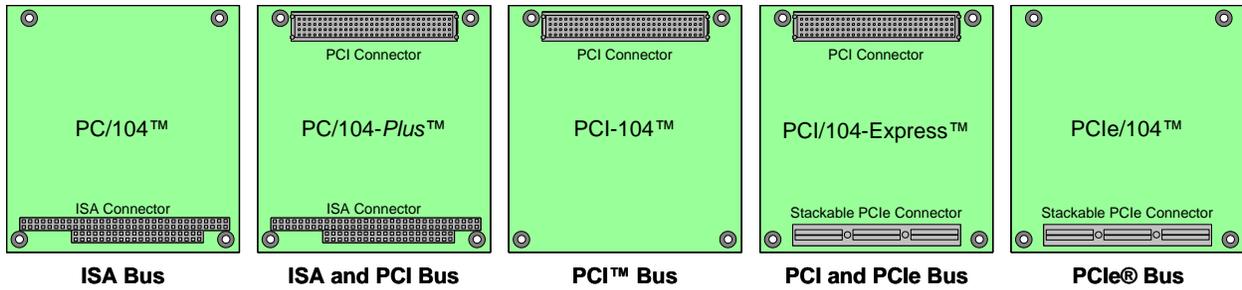
##### 3.3.1. Expansion Bus Connectors

The stackable PC/104 architecture offers three busses in various combinations and all are defined on EBX form factor.

The busses are:

- PCI Express is a high density, high speed stacking surface mount connector pair.
- PCI is the 120-pin connector, a high-density pin-and-socket connector with 2mm pin-to-pin spacing.
- ISA bus is the 104-pin ISA connector pair which consists of 64-pin and 40-pin pin-and-socket headers with 0.1-in. pin-to-pin spacing.

The bus combinations supported by the PC/104 Consortium are show below:



**Figure 2 PC/104 Bus Options**

### 3.3.2. Stackthrough Bus Option

An EBX form factor board may be populated with either stacking or non-stackthrough bus connectors. When fitted with stackthrough bus connectors, the EBX board can be plugged onto another circuit board (often called a “baseboard”) and treated like a single-board computer “macrocomponent”.

### 3.3.3. PC/104-Plus Keep Out Area

The EBX form factor preserves the mandatory “keep out” areas defined by the PC/104, PC/104-Plus, PCI-104, PCI/104-Express, and PCIe/104 specifications.

## 4. VERTICAL CLEARANCE ZONES

The EBX form-factor is subdivided into zones that are intended for various interfaces and components. Each of these zones, and their associated functions, are defined in Figure 5 and Figure 6 and are described below. Each zone has a specified vertical dimension within which all components of that zone must fit. Table 1 specifies the maximum component height within each EBX zone.

Figure 5 or Figure 6 will apply, depending on whether the Tall CPU or PC Card option is desired. Many EBX form factor compliant boards have single board computer functions, including memory expansion, PC Card slots, Ethernet ports, mass storage and auxiliary ports, and CRT and LCD interfaces. The EBX form factor does not require all these functions, nor does it specify that they *must* appear in a particular location. However, observing these guidelines facilitates interoperability among multiple EBX form-factor products, such as compatibility with multi-vendor packaging.

**Table 1 EBX Vertical Clearance Zones**

<b>Zone</b>	<b>Description</b>	<b>Max. Component Height Inch (mm)</b>
<b>A</b>	Memory expansion	1.5" (38.1mm)
<b>B</b>	Power connector	0.5" (12.7mm)
<b>C</b>	Video I/O (option) (includes mating connectors)	0.75" (19.1mm)
<b>D</b>	Misc. primary side components	0.75" (19.1mm)
<b>E</b>	General purpose I/O, tall region (includes mating connectors)	0.75" (19.1mm)
<b>F</b>	PC/104 stackable expansion location (Primary <u>and</u> secondary side)	See PC/104-Plus or PCI/104-Express specification
<b>G</b>	PC/104 architecture module I/O areas	0.600" (15.24mm)
<b>H</b>	Tall CPU (option) (includes heat sink)	1.2" (30.5mm)
<b>I</b>	PC Card slot (option)	0.6" (15.2mm)
<b>J</b>	General purpose I/O, low profile region (includes mating connectors)	0.5" (12.7mm)
---	Secondary side components	0.19" (4.8mm)
---	Board thickness	0.062" (1.57mm)

#### **4.1. Zone A: Memory Expansion**

Most EBX form factor boards will require expansion memory, and this zone is recommended to allow the height profile necessary for industry standard SIMMs or DIMMs.

#### **4.2. Zone B: Power Connector**

The power connector and external mating connector are located in this zone. Refer to Section 5 of this specification for further information.

#### **4.3. Zone C: Video I/O (Option)**

Many EBX form factor boards will provide onboard interface to CRT and/or flat panel displays. It is recommended that the I/O connectors for external display devices be located within this zone. Both the EBX form factor board connectors and the typical mating cable connectors must fit within the defined height profile.

#### **4.4. Zone D: Miscellaneous Primary Side Components**

Any primary side components within this zone must fit within the defined height profile.

#### **4.5. Zone E: General Purpose I/O, Tall Region**

This zone is defined for I/O expansion interfaces for functions such as IDE, floppy, SCSI, keyboard, mouse, serial ports, parallel ports, etc. Both the EBX form factor board connectors and the typical mating cable connectors must fit within the defined height profile.

#### **4.6. Zone F: PC/104 Architecture Expansion Stack Location**

This zone is for the onboard PC/104, PC/104-*Plus*, PCI-104, PCI/104-Express, or PCIe/104 expansion stack. For the required height profile within this zone, refer to the PC/104-*Plus* or PCI/104-Express specification.

#### **4.7. Zone G: PC/104 Architecture I/O Areas**

The two areas marked “G” correspond to the I/O connector areas of the PC/104, PC/104-*Plus*, PCI-104, PCI/104-Express, and PCIe/104 module specifications. Components on the EBX board must not be too tall to fit beneath the I/O connectors of the PC/104, PC/104-*Plus*, and PCI-104 modules and must therefore conform to the height profile defined for this zone. Note that the PC/104, PC/104-*Plus*, PCI-104 modules, PCI/104-Express, and PCIe/104 I/O connectors and

mating cable connectors are expected to fit entirely within the two sets of horizontal boundaries indicated by “G” in Figure 5 and Figure 6.

#### **4.8. Zone H: Tall CPU (Option)**

CPUs requiring a tall heatsink or fan attachment are recommended to be located in this zone, as defined in Figure 5. The defined height profile for this zone includes the CPU and its associated heatsink assembly. In this case, use of PC Cards will require a PC/104, PC/104-*Plus*, PCI-104, PCI/104-Express, or PCIe/104 expansion module or other external adapter.

#### **4.9. Zone I: PC Card/Express Card Slot (Option)**

If an onboard PC Card or Express Card expansion slot is used, its location should be as defined in Figure 6. When fully inserted, the external edge of the PC Card is flush with the outside edge of the EBX form factor board as indicated in Figure 6; the location of the center of the card is also indicated in Figure 6.

#### **4.10. Zone J: General Purpose I/O, Low Profile Region**

This zone is defined for I/O expansion interfaces for functions such as IDE, floppy, SCSI, keyboard, mouse, serial ports, parallel ports, etc. Both the EBX form factor board connectors and the typical mating cable connectors must fit within the defined height profile.

#### **4.11. Secondary Side Components**

All components on the “secondary side” (bottom) of the EBX form factor board, with the exception of the PC/104-*Plus* module area, must fit within this dimension. If the “stackthrough bus” option is employed, secondary side components in the PC/104 architecture module area must conform to the secondary side component height requirements specified in the PC/104-*Plus* or PCI/104-Express specification.

#### **4.12. Board Thickness**

This dimension specifies the thickness of the EBX form factor PC board material.

## 5. POWER CONNECTOR AND POWER REQUIREMENTS

Figure 5 and Figure 6 define the region where the power connector and its mating cable connector must be located. The power connector should be placed close to the top mating hole within the specified connector region.

The type of power connector placed at this location is defined by the designer of their specific EBX form factor board.

### 5.1. Power Requirements

The EBX and EBX Express specification only defines the available input voltages; it does not specify any electrical requirements for any of the referenced standards such as PC/104, PC/104-*Plus*, PCI-104, PCI/104-Express, PCIe/104, PC Card, ExpressCard, or the various supported I/O interfaces.

Specified input voltages are given in Table 2. EBX form factor boards are not obligated to use all these voltages.

**Table 2 Power Connector Voltage Requirements**

Supply	Maximum Voltage	Minimum Voltage
+12V	+12.6V	+11.4V
+5V	+5.25V	+4.75V
+3.3V	+3.45V	+3.15V
Ground	---	---

## 6. EBX AND EBX EXPRESS FORM FACTOR

### 6.1. EBX Detailed Mechanical Dimensions

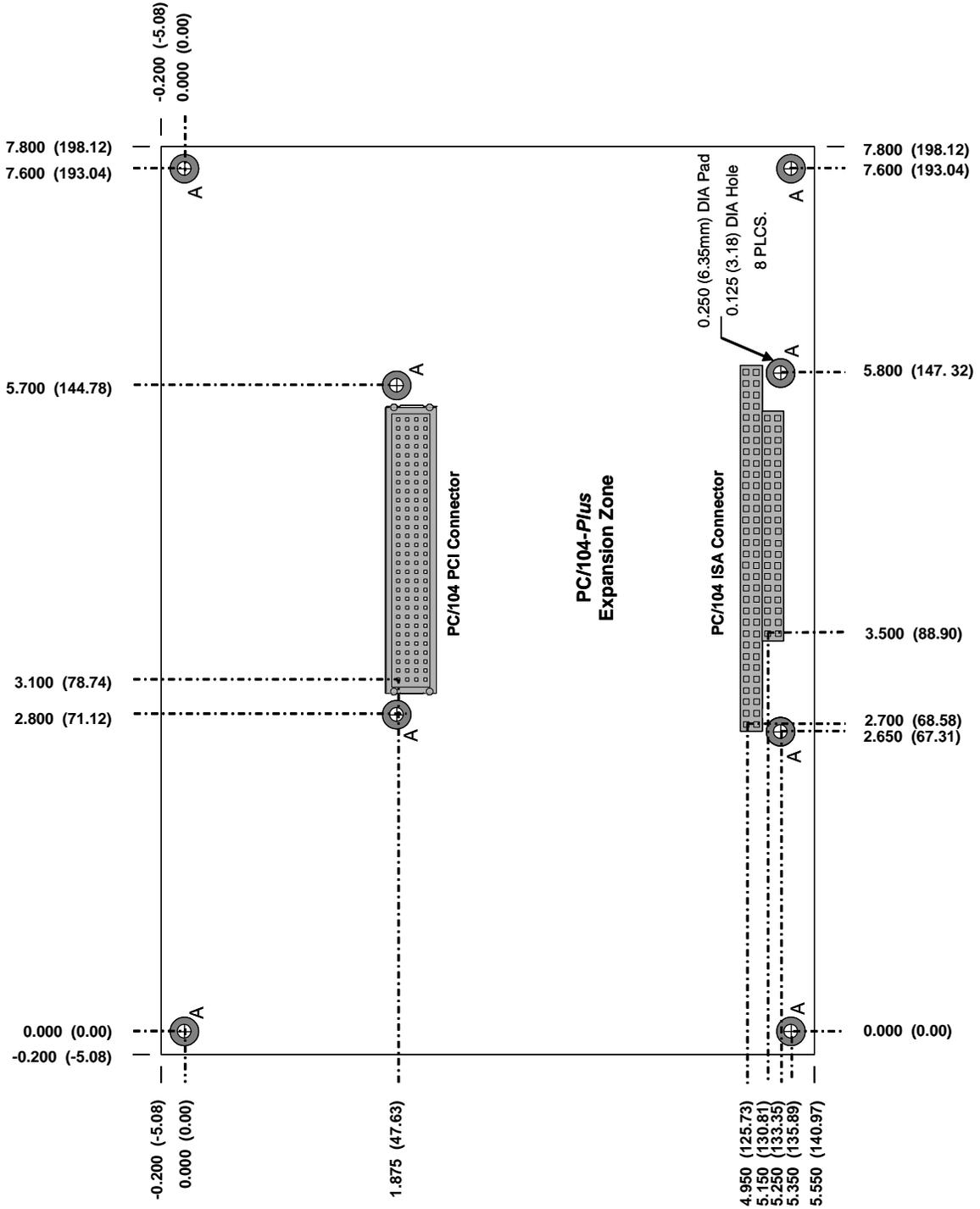


Figure 3 EBX Detailed Mechanical Drawing

## 6.2. EBX Express Detailed Mechanical Dimensions

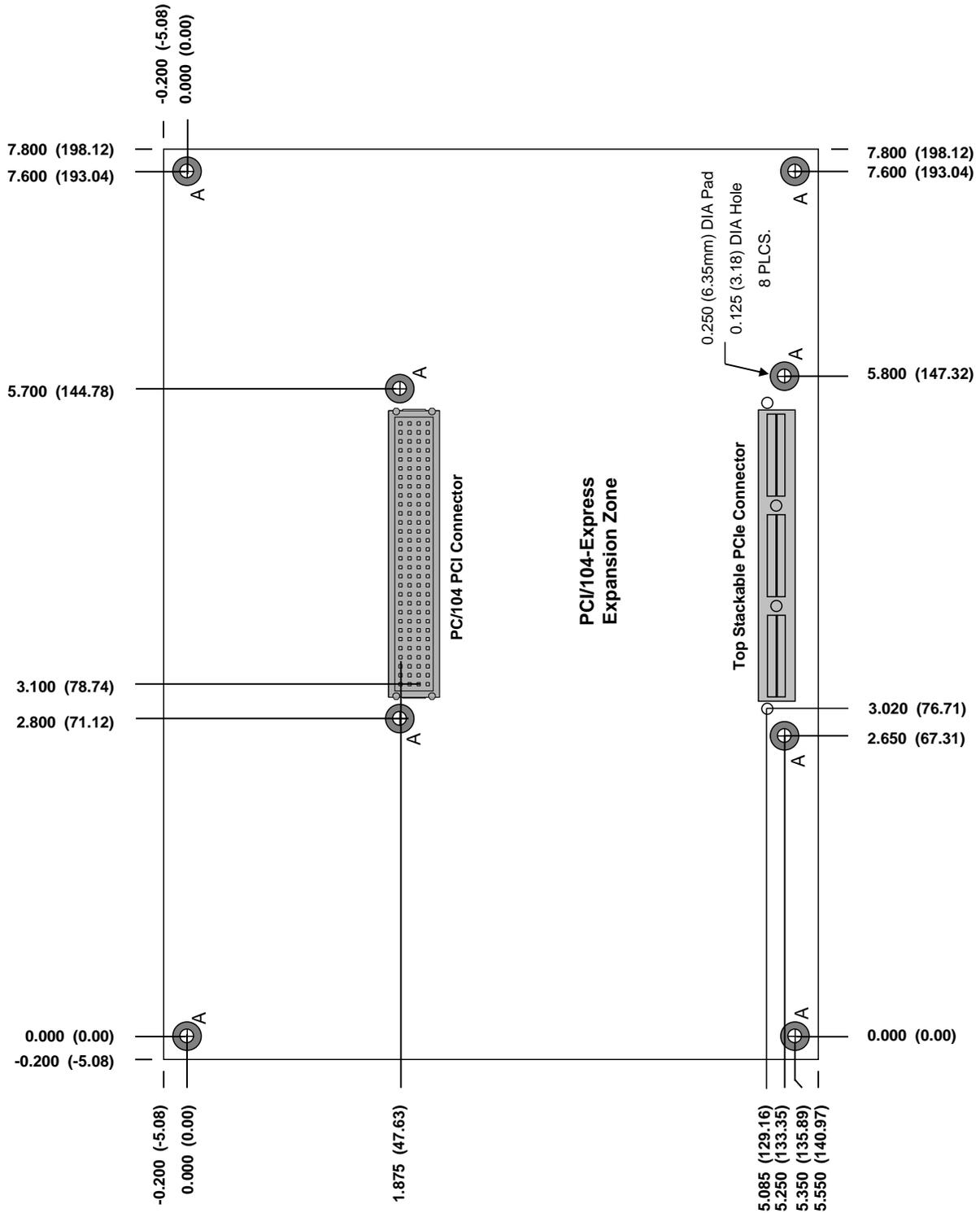


Figure 4 EBX Express Detailed Mechanical Drawing

### 6.3. EBX and EBX Express Component Zones, Tall CPU Option

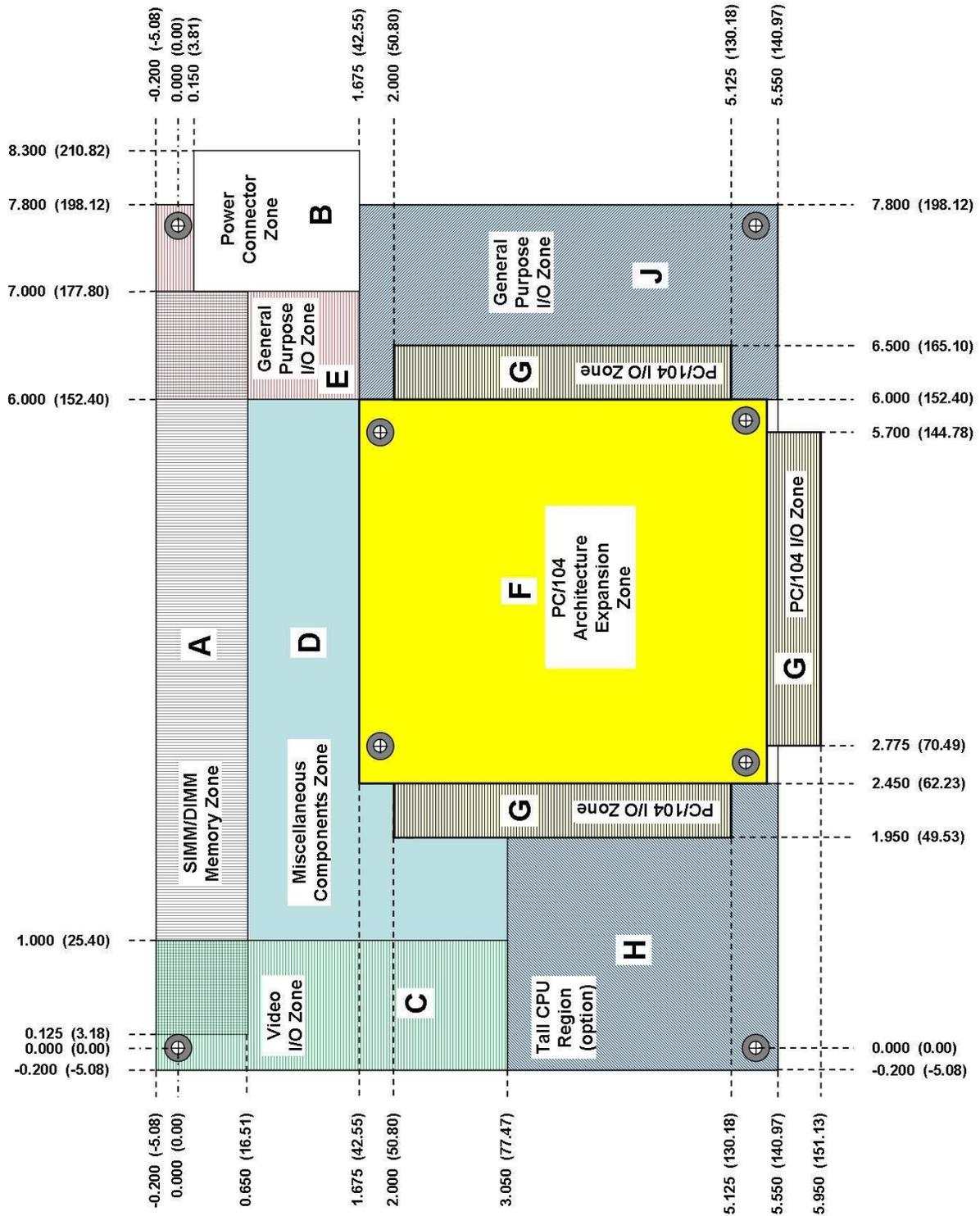


Figure 5 EBX and EBX Express Component Zones, Tall CPU Option

### 6.4. EBX and EBX Express Component Zones, PC Card Slot Option

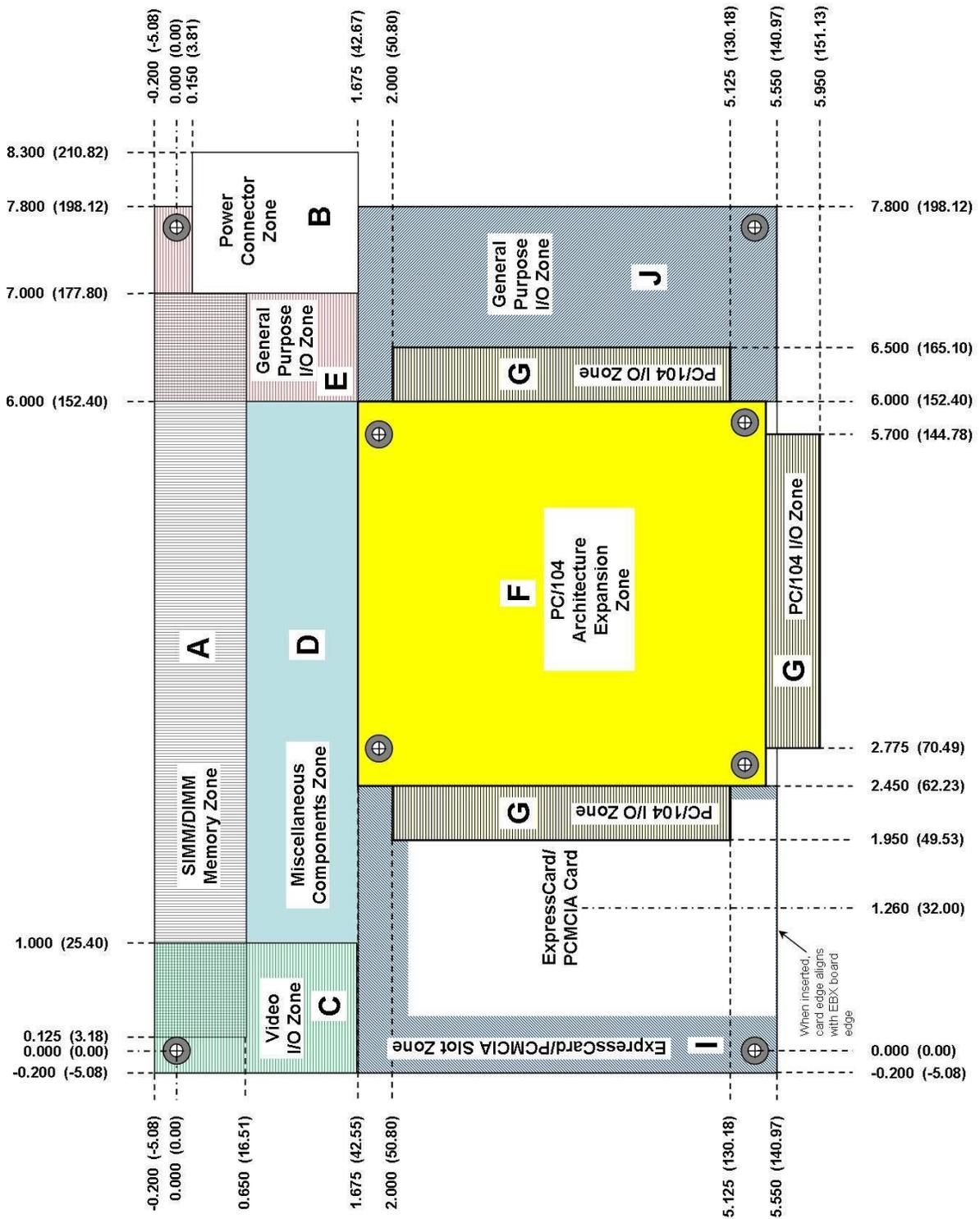


Figure 6 EBX and EBX Express Component Zones, PC Card Option

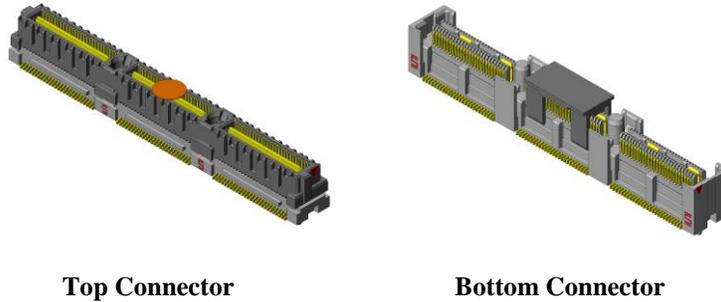
## 7. CONNECTORS

### 7.1. PCI Express Connector

The QMS/QFS series connectors from Samtec's High Speed Interface line were designed for PC/104's 0.600 inch (15.24mm) stacking height and standoff tolerances. An equivalent connector can be used.

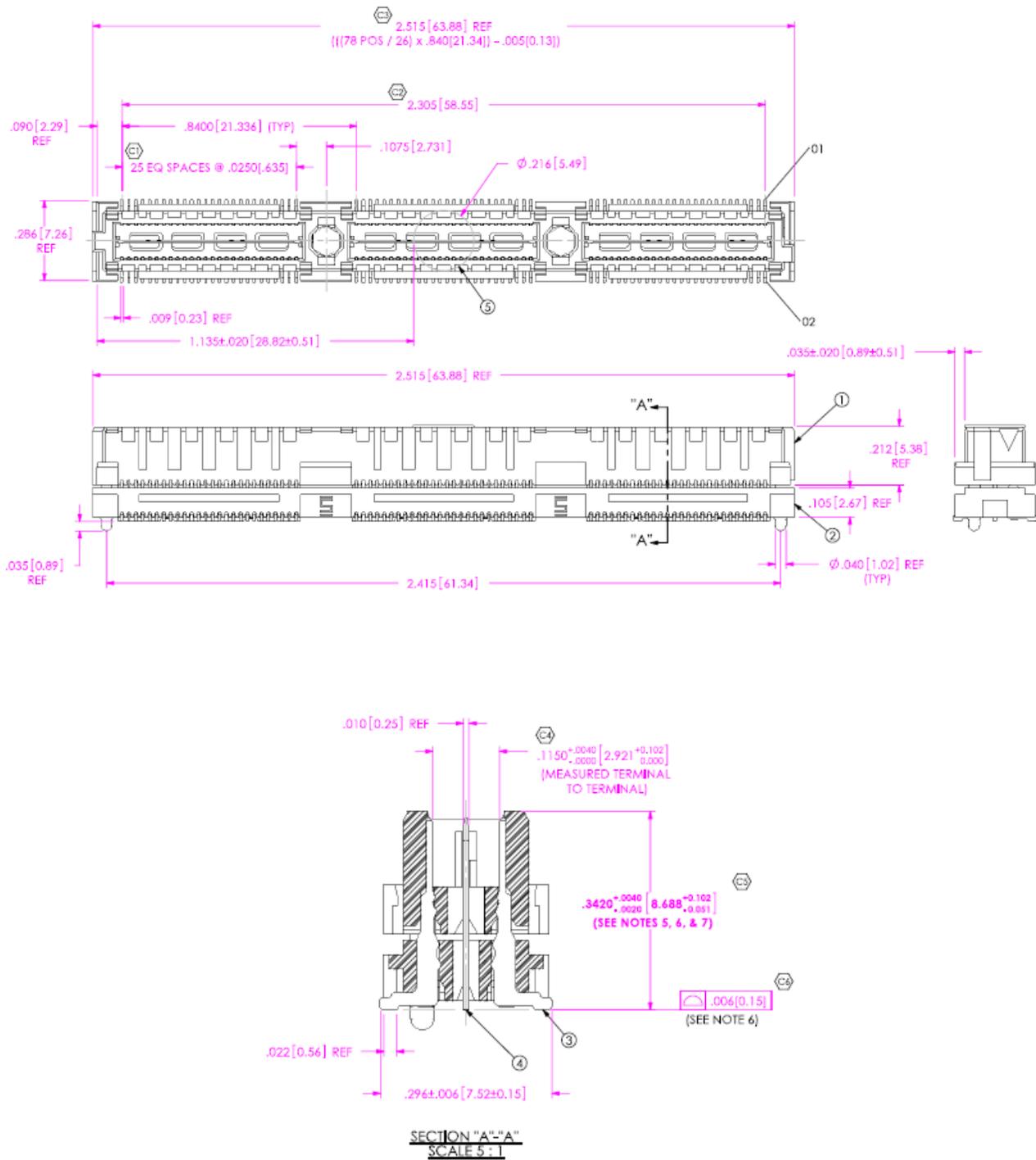
#### 7.1.1. Part Number

Top Connector: ASP-129637-03 with 0.600 inch (15.24 mm) stack height based on QMS or equivalent  
Bottom Connector: ASP-129646-03 with 0.600 inch (15.24 mm) stack height based on QFS or equivalent



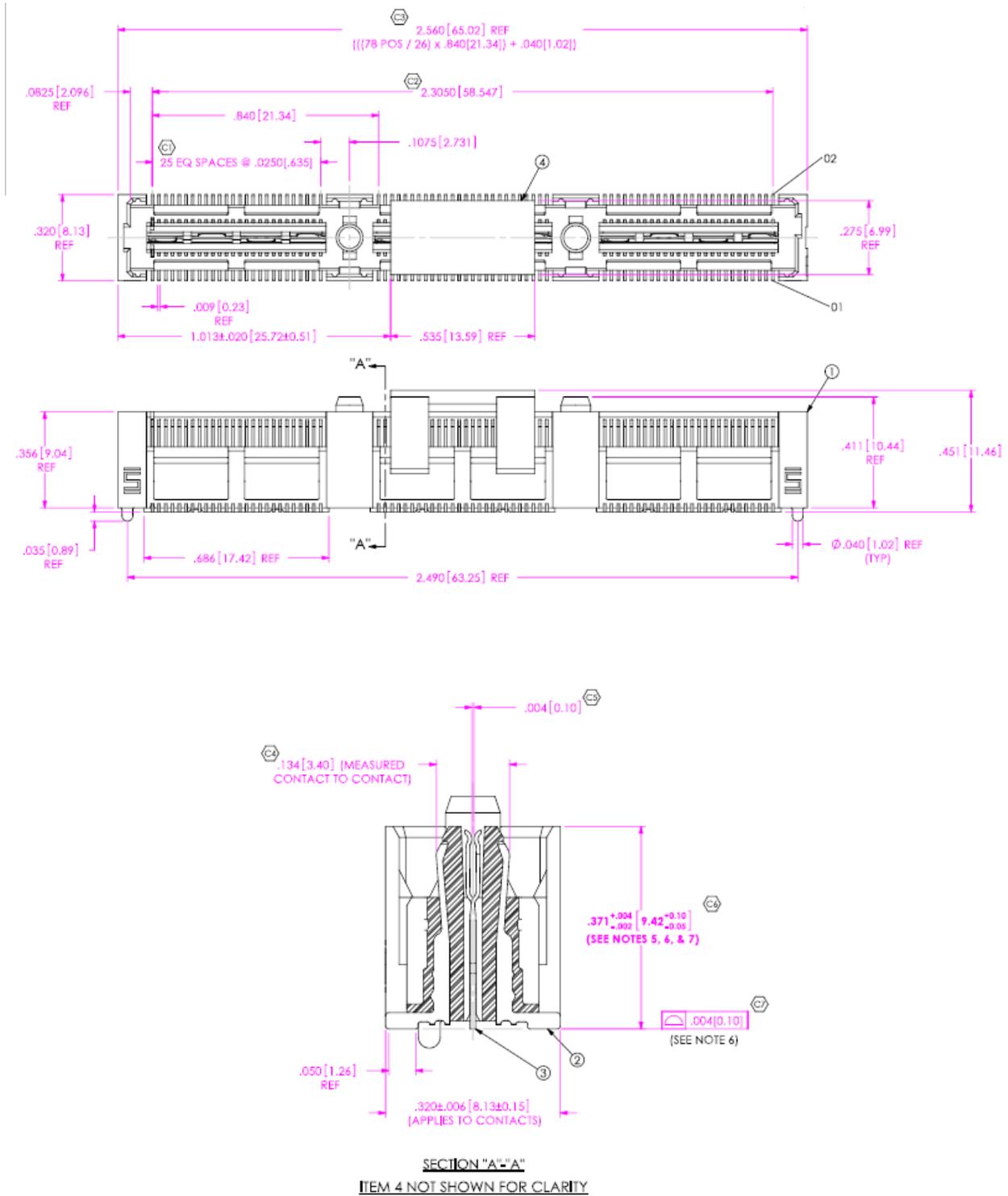
**Figure 7: Top Half and Bottom Half of Connector A Shown with Pick-and-Place Adapters**

### 7.1.2. ASP-129637-03 or equivalent (Top Connector) Mechanical Drawings



**Figure 8: ASP-129637-03 or equivalent Mechanical Drawings**

### 7.1.3. ASP-129646-03 or equivalent (Bottom Connector) Mechanical Drawings



**Figure 9: ASP-129646-03 or equivalent Mechanical Drawings**

#### 7.1.4. PCI Express Connector Specifications

##### **MATERIALS**

Housing:	Liquid Crystal Polymer
Terminal & Ground Plane Material:	Phosphor Bronze
Terminal Plating:	Au over 50 $\mu$ " (1.27 $\mu$ m) Ni
Plane Plating:	Au over 50 $\mu$ " (1.27 $\mu$ m) Ni
Terminal and Plane Tails:	Tin

##### **CONTACT FINISH**

Socket Interface:	30 $\mu$ " Au
Terminal Interface:	30 $\mu$ " Au
Underplate:	50 $\mu$ " Ni

##### **MECHANICAL PERFORMANCE**

Insertion Force:	13.9 lbs initial & 16.8 lbs @ 100 cycles
Withdrawal Force:	9.8 lbs initial & 10.0 lbs @ 100 cycles
Normal Force @ nominal deflection:	69 grams
Minimum stacking size:	14.8mm
Nominal stacking size:	15.24mm
Maximum stacking size:	15.50mm
Contact wipe (at nom. Height):	.044" [1.22mm]
Ground Plane wipe (at nom. Height):	.059" [1.50mm]
Durability:	50 cycles
Operating Temp:	-55°C to 125°C

##### **ELECTRICAL PERFORMANCE**

Positions	Three banks of 52 pins & 1 plane for 156 pins and 3 planes.
Contact Resistance (initial):	30 mOhms
Contact Resistance (@ 1,000 cycles):	50 mOhms
Contact Current Capacity:	1.8A at 85°C and with 20% Industry Standard
Derating Factor	
Ground Plane Resistance:	0.5 mOhms
Ground Plane Current Capacity:	8.4A at 85°C and with 20% Industry Standard
Derating Factor	
Dielectric Withstanding Voltage:	900 VAC
Working Voltage:	300 VAC
Insulation Resistance:	50,000 megaOhms

##### **SOLDERABILITY**

Maximum Processing Temperature:	230°C for 60 seconds or 260°C for 20 seconds
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## **HIGH FREQUENCY PERFORMANCE**

Differential Pair Impedance

100 Ohms nominal +/- 10%

Single-Ended Impedance

50 Ohms nominal +/- 10%

Differential Return Loss (SDD11):

-15dB @ 1.25 GHz; -8dB @ 5 GHz

Differential Insertion Loss (SDD21):

-1dB @ 1.25 GHz; -3dB @ 5 GHz

Differential Near End Crosstalk (SDD31):

-45dB @ 1.25 GHz; -35dB @ 5 GHz

Differential Far End Crosstalk (SDD41):

-45dB @ 1.25 GHz; -25 dB @ 5 GHz

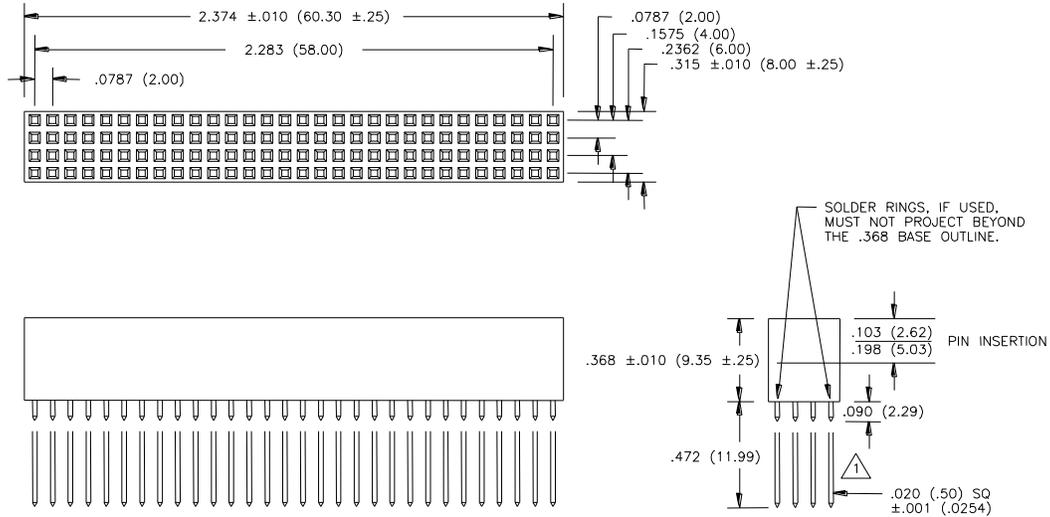
## 7.2. PCI Connector

### 7.2.1. PCI Connector Mechanical

NOTES:

△ PRESS FIT COMPLIANT PINS PER IEC 352-5 CAN BE USED INSTEAD OF SQUARE PINS AS SHOWN.

2 CONFIGURATION CAN BE MADE OF ONE OR MORE PIECES.

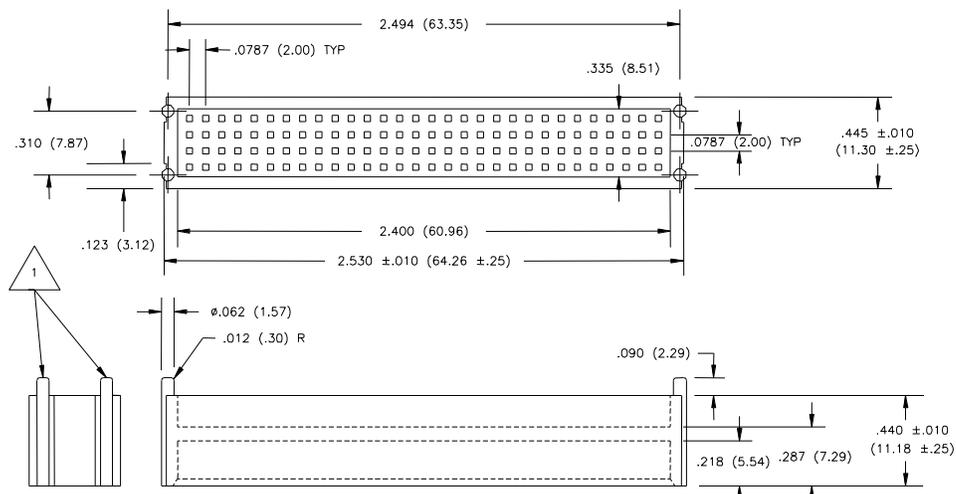


**Figure 10 PCI Connector Mechanical Drawing**

### PCI Connector Shroud

NOTE:

1 LOCKING PEGS ARE NOT REQUIRED IF THE SHROUD IS PRESS FIT ONTO THE LONG CONNECTOR PINS OR OTHERWISE SECURED.



**Figure 11 PCI Connector Shroud Mechanical Drawing**

## 7.2.2. PCI Connector Specifications

### **MATERIALS**

Housing:	High Temp Thermoplastic, UL Rated 94-V0
Contact:	Phosphor Bronze
Solder:	Tin-Lead (63-37), If Applicable
Solder Clip:	Aluminum Alloy, If Applicable

### **CONTACT FINISH**

Female Interface:	15 Microinches Minimum Hard Gold
Male Interface:	Gold Flash Minimum
Solder Tail:	100 Microinches Minimum Solder
Underplate:	50 Microinches Minimum Nickel

### **MECHANICAL PERFORMANCE**

Insertion Force:	2.5 Ounce Per Pin Maximum
Withdrawal Force:	1 Ounce Per Pin Minimum
Normal Force:	50 Grams Minimum (Per Beam)
Durability:	50 Cycles Minimum
Operating Temp:	-55° C to +85° C Minimum

### **ELECTRICAL PERFORMANCE**

Contact Resistance:	<30 Milliohms Maximum
Current Capacity:	1 Amp Continuous Per Pin
Dielectric Strength:	500 VAC
Insulation Resistance:	5,000 Megaohms Minimum



### 7.3.2. 8-Bit and 16-Bit ISA Connector Specification

#### **MATERIALS**

Housing:	High Temp Thermoplastic, UL Rated 94-V0
Contact:	Phosphor Bronze
Solder:	Tin-Lead (63-37), If Applicable
Solder Clip:	Aluminum Alloy, If Applicable

#### **CONTACT FINISH**

Female Interface:	15 Microinches Minimum Hard Gold
Male Interface:	Gold Flash Minimum
Solder Tail:	100 Microinches Minimum Solder
Underplate:	50 Microinches Minimum Nickel

#### **MECHANICAL PERFORMANCE**

Insertion Force:	3.5 Ounce Per Pin Maximum
Withdrawal Force:	1 Ounce Per Pin Minimum
Normal Force:	50 Grams Minimum (Per Beam)
Durability:	50 Cycles Minimum
Operating Temp:	-55° C to +85° C Minimum

#### **ELECTRICAL PERFORMANCE**

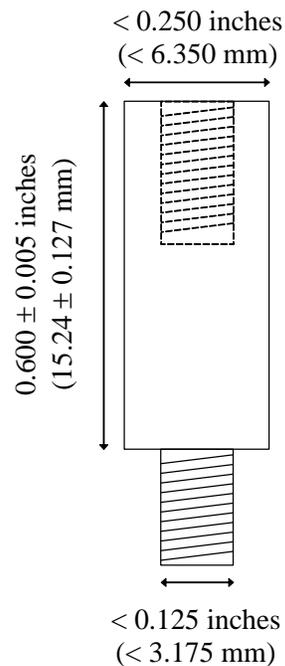
Contact Resistance:	<30 Milliohms Maximum
Current Capacity:	1 Amp Continuous Per Pin
Dielectric Strength:	1000 VAC
Insulation Resistance:	5,000 Megaohms Minimum

## 8. STANDOFF

### 8.1. Standoff Mechanical

Standoffs are used to ensure stacked boards retain their connectivity. The standoffs are preferably made from stainless-steel to provide for maximum strength and height tolerance. Pads must be provided for the standoffs, with the same plating as the pads for the PCIe connectors.

All critical dimensions are listed. It is up to the user to define the thread typed. The height of the standoff shall be  $0.600'' \pm 0.005''$ . The width of the standoff must be able to fit on the Standoff pad called out on the Board Layout & Dimensions Section. The width of the threaded section must be able to fit into the standoff pad hole called out in the Board Layout & Dimensions Section.



**Figure 13 Standoff Mechanical Dimensions**