Mezzanine Cards, Flexible Bus Expansion Technology

Increase System Performance via Economical Means

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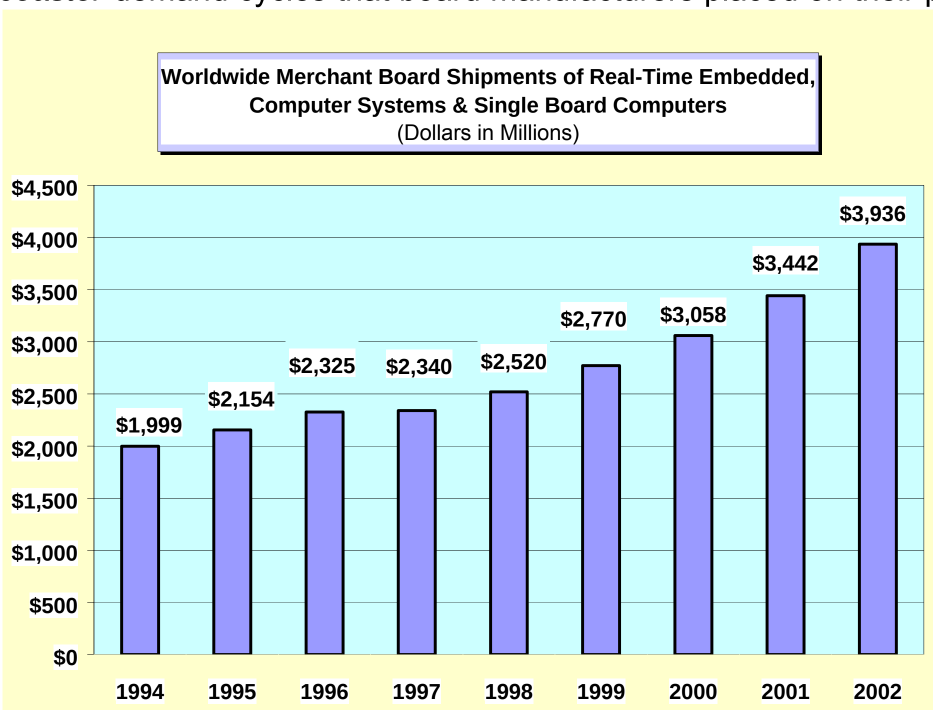
Mezzanine Cards offer great flexibility and upgrade capabilities to bus architectures, Single Board Computer (SBC) manufacturers, and users alike. The cards provide a means of bus expansion by adding additional or specialized I/O to a main processor board. In 1997 SBC shipments containing mezzanine cards reached 73.5%, (source: Venture Development Corporation). Since that time, system designers have continually expanded the application of these cards into new technologies such as the VME Extensions, (VME64x), and CompactPCI, (cPCI). The benefits are apparently growing in appeal as system *customization* is now possible with off-the-shelf components. During the past decade, connector manufacturers participating in this market segment have experienced the effects of *roller-coaster* demand cycles that board manufacturers placed on their production facilities. Leaders in the connector segment responded to these *push-pull* production schedules by establishing much closer relationships with merchant board OEM's. They initiated cost effective, flexible material management programs that were able to respond to market surges with minimal disruption to the production environment. In retrospect, (reference chart courtesy of Venture Development Corp.), the overall growth of the market has increased steadily since 1994, and to date, has delivered a 6.3% CAGR. As has typically occurred in the past, once again, the introduction of several new generations of microprocessors and advanced packaging techniques have spawned the need for newer higher density and higher speed mezzanine connectors. Additionally, the mezzanine card industry has been propelled by advances in dielectric materials, card fabrication processes, surface mount technology, (SMT) and the availability of highly sophisticated pick-and-place equipment. As a result, systems designers are finding new ways to reduce system cost and deliver even more functionality to their end users. So, the market will continue to grow for the foreseeable near term and is projected to return an 8.8% CAGR through the year 2002.



<u>Mezzanine Cards, Flexible Bus Expansion Technology</u>

Today's leading mezzanine technologies include PMC, PC•MIP and IndustryPack®, (IP). PMC and PC•MIP use the industry standard PCI connector interface which offers reliable connectivity and high performance data transmission. PCI Bus has a large installed base and is a very fast expansion interface which has no "wait-states", thus making it the ideal choice for use with a mezzanine system. The IEEE's Common Mezzanine Card standard defines card size, connector type, I/O mapping, and location of the connector on the card. PMC is controlled by *IEEE P1386.1*, PC•MIP is controlled by *the VITA-29 Task Group*, and IP modules were originally approved under the *ANSI/VITA 4-1995* standard. At present, IP is the market leader based upon the number of installed mezzanine boards. However, PMC has grown in popularity to achieve approximately 20% of the worldwide share of merchant VME SBC shipments, (source: Venture Development Corporation). The balance of this article will provide an overview of mezzanine card technology as it pertains to the system designer, the connector manufacturer, and the end user. It is only through this type of discussion that the relationship between these three disparate groups can be understood.

<u>Mezzanine Considerations</u>

When a system designer elects to add a mezzanine card to a CPU, a wide variety of products are available to choose from. In many instances, a mezzanine board is used to personalize I/O functions. This means that on one side, a mezzanine board should have a computer connection to the "Host" board, and on the other side, it must provide I/O mapped connections to allow signals to leave the board. These I/O signals may exit the mezzanine board at either the front panel or the Host board itself. Whichever exit scheme is employed, depends principally on system performance requirements and designer discretion. However, there are 3 basic rules which limit the designer's choice of mezzanine boards.

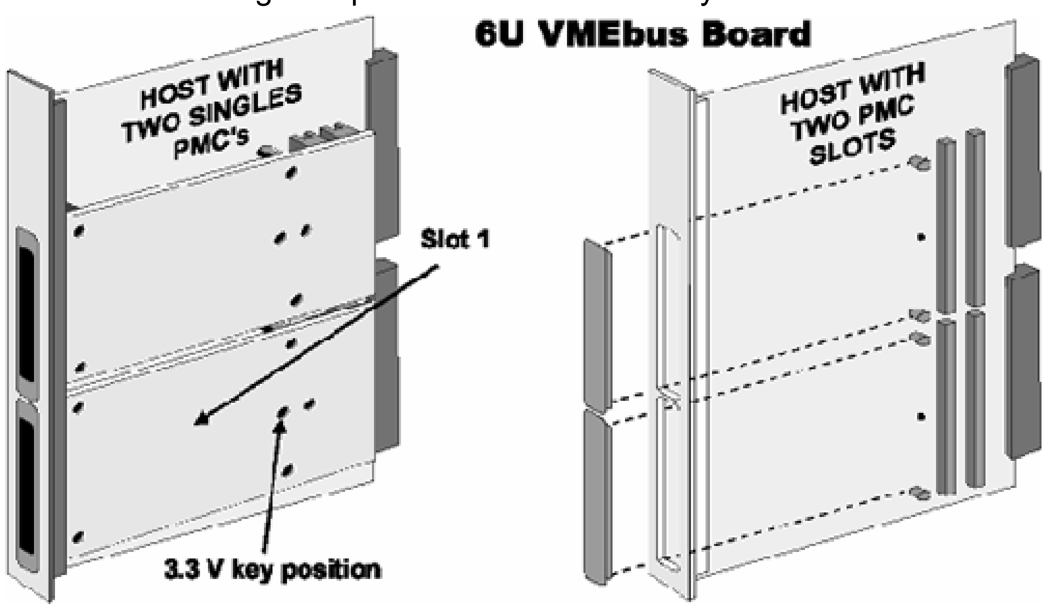
- <u>Rule #1, Size & Connector Type:</u>
  How big is it? How much space will it require? The type of connector and its location on the card is also important. Board size relates directly to the quantity and complexity of the electronic components that can be placed on the mezzanine board. Board size is also directly related to the manufacturing price, as larger, fully populated boards cost more to produce. The connector type must compliment the complexity of the bus by its number and type of contacts. The connector's construction and mechanical attributes are also indicative of its robustness and reliability.
- <u>Rule #2, Bus Performance & Interface Aspects:</u>
  What is the bandwidth requirement? What Voltage level will be run? How much power must be dissipated? For example, IndustryPacks, (IPs), support 16 and 32-bit data paths, but IPs are usually 16 bit. PC•MIP modules use the 32 bit PCI format. PMCs have a 64 bit option, but most PMCs and Host boards are 32 bit. Are signals triggered at 3.3 v or 5 v? Another important element to consider is cooling. Temperatures rise dramatically due to the mezzanine being stacked parallel to the Host board. Suffice to say for the purposes of this discussion, system designers must give serious consideration to providing forced air cooling between the boards.

- Rule #3, What Is Available:
  What is in production and what is available to the system designer today? If backward compatibility is a requirement, and a legacy CPU "HOST" board already has PMC sites on it, for example, then the choice of the mezzanine card is made by default.

The following discussion will examine the *mezzanine applications* of IP, PMC and PC•MIP host boards and cards at the mechanical level. The discussion will include descriptions of the board size, connectors used and how I/O to external interfaces is done.

"PMC" Mezzanine Applications:

The popularity of the PMC board stems not only from it's performance attributes, but also because of it's large size. The PMC was originally developed with the intention of allowing high volume users to create their own internal mezzanines for standard VME CPU boards. With a peak theoretical bandwidth of 132 Megabits per second, applications that are attracted to PMC are typically those involving high performance or intelligence such as communications and system expansion. It is conceivable to anticipate additional high-end applications to grow in popularity, such as fiber channel RAID arrays and other systems where bandwidth in excess of 100 Megabits per second is a necessity. All PMC cards adhere to IEEE's Common Mezzanine Card specification and fit a form factor of 74 mm x 149 mm, (~3 x 5 inches). A 3U VME Host can accept one PMC module, and a 6U Host will accept two modules side by side. Each PMC module uses two 64-pin PCI connectors as the Host interconnect and may use either one or two 64-pin PCI connectors as the I/O interconnect. PMC modules are also available in 64-bit versions which use three 64-pin PCI connectors as the interconnect in each of the Host and I/O applications described previously. The maximum component height on a PMC is 9.8 mm, (~⅜ inches). Depending upon adjacent slot restrictions and system configuration It may be possible to place low profile components on the top surface of a PMC card. PMC modules also have I/O exit capabilities located at the face plate as shown in the figure above.



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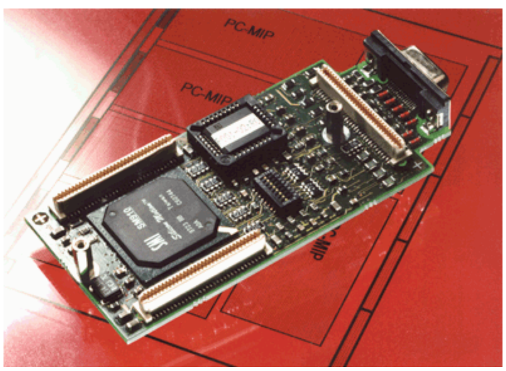
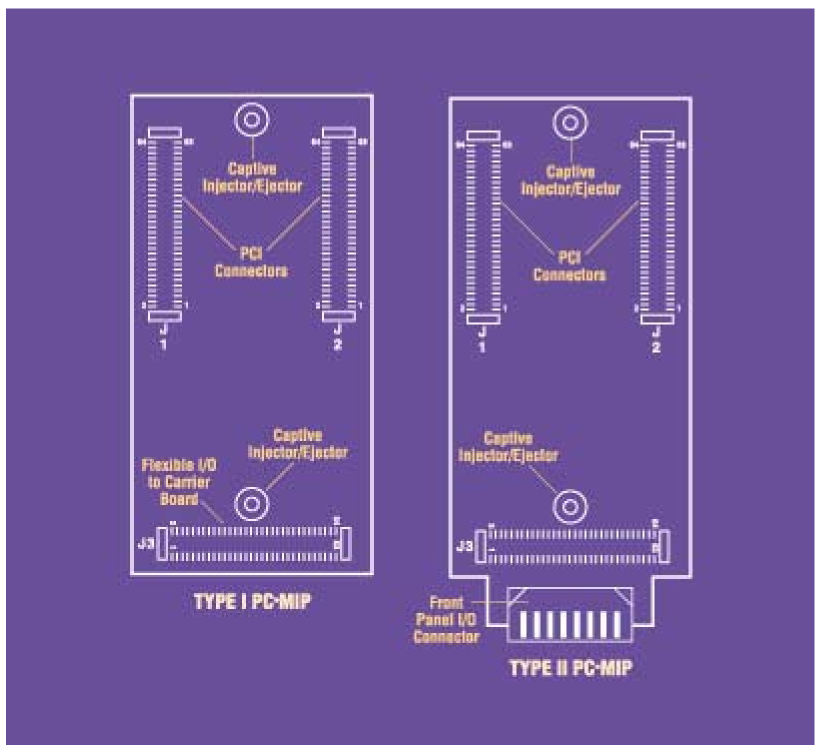
"PC•MIP" Mezzanine Applications:

Density is the greatest asset offered by PC•MIP modules. Introduced in 1998, with first production shipments in 1999, this new standard continually grows in popularity. This new generation of mezzanine is compatible with *embedded* system designs, i.e., SCSI, Fast Ethernet, ATM, Video, and IEEE-1394 (FireWire). It is based on standard "PCI Bus" architecture. To ensure it's continued development, Motorola Computer Group joined the effort to sponsor a task group under the ANSI VITA Standards Organization. Schroff also joined that effort by providing newly designed front panel standards as well as off-the-shelf mechanical components. The key advantages of PC•MIP are its high density and low cost. PC•MIP modules can fit more modules onto both 3U and 6U form factors. Because it uses surface mount connectors, the PC•MIP, (despite it's smaller card size), has more surface area available to mount components on than an IP module. The module can have components mounted on both sides, and the OEM may choose where to place the highest components:

- Type I: 3.3 mm height on back side, 5.7 mm height on front (PCB included), and
- Type II: 5.3 mm height on back side, 3.7 mm height on front (PCB included).

Additionally, the modules incorporate standardized injector/ejector hardware which protects the connectors and facilitates ease of installation and removal.

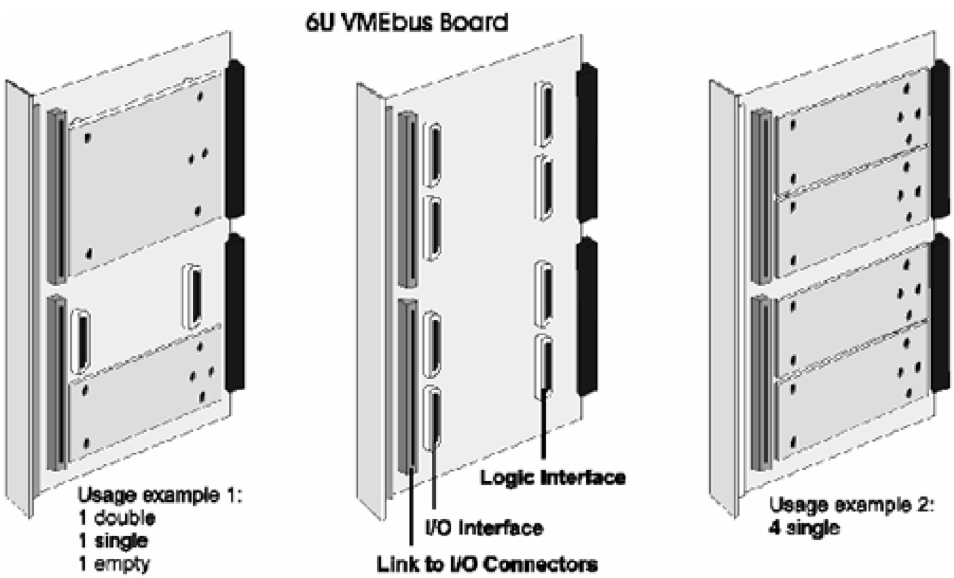




PC•MIP modules are available in two configurations: Type I, (47.5 mm x 90 mm), for rear panel I/O; and Type II, (47.5 mm x 99 mm), for front panel I/O applications. The 50 position PCI connector interface for the Host board and the I/O function are located at opposite ends of the card. At the I/O end of the board, the user has the option to either use a flexible I/O connector or a front panel I/O connector. If the flexible I/O connector is used, then routing to the rear panel I/O connector is through the Host board. It also offers low noise, high speed signals to be easily routed away from the other digital circuitry. This is a critical advantage for applications such as Fast Ethernet, ATM and FireWire. In general, PMC and IP modules are targeted almost exclusively to VME system boards. Whereas, PC•MIP modules tend to suit OEM systems which have no backplanes at all.

Mezzanine Applications, continued:

IndustryPack, (IP), is 12 years old and is the most trusted card of the mezzanine world. Because of it's age, the standard was developed during an era of lower transmission speed and lower bandwidth performance criteria. Although it's 16-bit interface will not meet the performance demands of today's newer, more exotic systems, it doesn't have to. The IP niche is industrial I/O applications that address digital, analog, and serial bus applications where it's 40 Megabit per second data rate is more than adequate. Designers developing systems for these industrial applications tend to select a proven technology that meets their needs. New IP applications and design-wins continue to be strong. It is anticipated that IPs will remain viable in the industrial segment for at least another ten years.



IndustryPack modules are available in *single* and *double* size. In it's double size, the format is slightly larger than a PC•MIP module. A single IP measures 45.7 mm x 99 mm, (~1.8 x 3.9 inches), and a double IP measures 91.4 mm x 99 mm, (~3.6 x 3.9 inches). Components mounted on an IP module are allowed to have a maximum height of 7.4 mm, (~0.29 inches). The single size IP module uses two 50-pin connectors; one for interfacing with the Host board and one to provide the I/O interface to exit the Host board. For example, on a 6U VME Host board there are provisions for four single size or two double size IP modules. As can be seen in the above figure, IP modules do not offer a front panel solution to exit I/O signals.

Mezzanine Module Summary

IP Modules

Because the bus is simple, it is easy and economical to develop an IP module. Because the PCB surface is small, production costs are limited. IP modules have a low performance interface, and because IPs are primarily used in slave applications, they are intended to be used as a simple I/O extension. From the points discussed earlier, it is clear that the IndustryPack module is well suited for a large number of non-intelligent I/O applications which do not require high performance.

Mezzanine Module Summary

PMC Modules

Whenever high data rate, high bandwidth, and intelligent I/O functions are required, PMC modules will remain the system designers choice in the foreseeable future. PMCs are more expensive than IPs because the board surface is larger, thus increasing production costs, and the PCI interface is more complex.

PC•MIP Modules

PC•MIP modules attempt to combine the best features of both the IP & PMC modules:

- Approximately the same board surface as the IP module, and
- Provides high speed signaling capabilities via a PCI interface as does the PMC module.

High performance and high intelligence applications are best served by PMC modules. Industrial applications that do not focus on high speed data rates are best served by IP modules. Presently, PC•MIP modules target the high performance niche where high bandwidth and high intelligence applications requiring high density connectors and low cost are the rule. Bus architectures where mezzanine technology is applied include VME, PCI, CompactPCI and embedded single board computers (SBCs).

In general, connector manufacturers participating in these market segments must keep abreast of OEM equipment trends and emerging technologies in the semiconductor industry. Historically, mezzanine module manufacturers have responded to increased CPU function with new mezzanine development. And, as can be seen throughout this discussion, the connector interface must be compatible with system performance criteria. The connector interface is not only performance driven, but is also cost sensitive. That being said, there are some obvious areas to which attention should be given and from which may develop an insight into how this dynamic market is evolving.

