

# EPIC: The New Mid-Size, Open-Standard for Embedded SBCs

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Most often the easiest and quickest way to build a system for demanding applications is to start by using a single board computer. While there are many technical and business factors involved with selecting a computer platform, one that can't be ignored is standardization. Standards for single board computers (SBC) are typically specified as to size and I/O expansion. The standards are administered by an industry trade organization to maintain uniformity and interoperability between manufacturers. Using an industry-standard SBC rather than a proprietary form-factor yields a better product that is available over a long period of time while at a competitive price from multiple vendors.

Surveying the universe of single board computers shows that they come in many sizes - from as small as a postage stamp to as large as a pizza box. System designers are familiar with VME, PCI, ISA, Compact-PCI and STD Bus. These are all well-known architectures each differentiated by various technical features, capabilities and board size. Each is similar in that their I/O expansion is through a bus and backplane. But for deeply embedded computing applications, there is a need to add even more functionality in less space. Advances in semiconductor density, packaging technology and connector technology have resulted in smaller SBCs

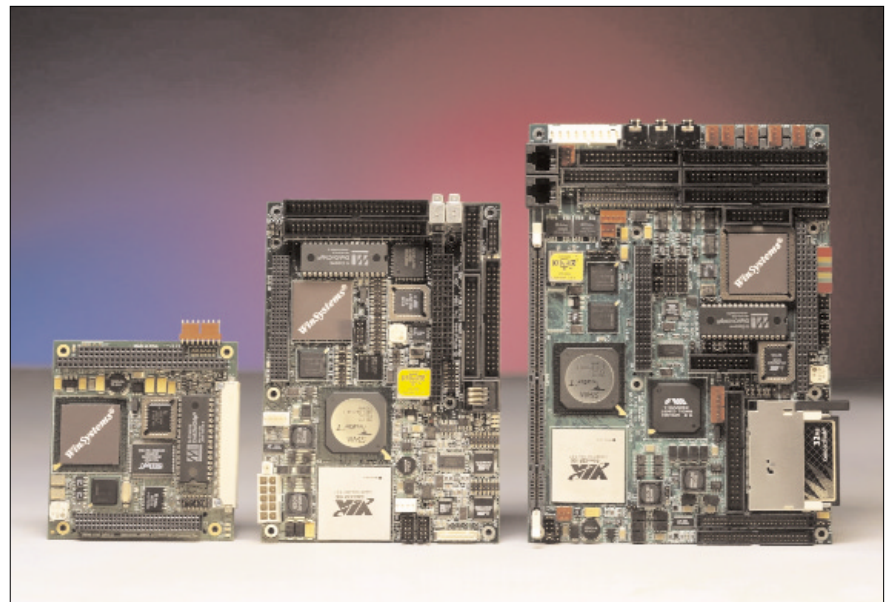
that offer different packaging and expansion style by using self-stacking I/O modules in lieu of a backplane. The PC/104 Consortium's EPIC standard is one such SBC style.

## Expandable SBCs

PC/104 and EBX are two industry-standard boards that address this stackable embedded market. PC/104 is the size of a 3.5" floppy disk, while EBX is the size of a CD/DVD drive. EBX's larger size is a two-edged sword. It allows higher

power processors to be supported plus more I/O connectors and functionality. Yet in space-constrained applications, PC/104 may be the only standard board that will fit. However, PC/104 may require multiple boards to satisfy the system requirements. Therefore a gap existed for compact applications between these two platforms.

Five companies: Ampro, Micro/sys, Octagon Systems, VersaLogic and WinSystems, worked together to define a mid-range, non-backplane



Pictured from left to right: PC/104, EPIC and EBX Embedded SBCs. The EPIC form-factor is well suited to a broad range of next-generation, feature-rich applications in industrial, medical military, transportation and commercial markets. The form-factor offers more space than PC/104, making it possible to fit faster CPUs and/or more I/O, yet requiring significantly less space than the larger EBX format.

## EPIC Specification

The non-profit PC/104 Consortium recently adopted the EPIC specification as an official standard. The open Embedded Platform for Industrial Computing (EPIC) is ideally suited for industrial and military applications because of its small size (115 mm x 165 mm) and flexible I/O options. In fact, EPIC allows PC/104 and PC/104-Plus modules to stack on top, thus leveraging the huge world of PC/104 I/O options. The EPIC specification is available on the PC/104 Consortium's web site under Technology Specifications.

EPIC's design goals were:

1. Establish a mid-size, open-standard platform for embedded single board computers (SBC).
2. Define a board that is a small, industrial-grade, embedded SBC with a variety of options for I/O expansion via PC/104, PC/104-Plus, USB, Ethernet and so on.
3. Specify a board size that is complementary to EBX and PC/104.
4. Emphasize a connector area for "real-world" I/O.
5. Create a specification to be adopted by an independent technical standards body.

Unlike PC/104, EPIC leaves plenty of room for the latest processors, including their heatsinks and fan assemblies. The standard's Appendix A also allows for a flexible power connector, or a keep-out area for a custom connector.

expandable SBC called EPIC (The Embedded Platform for Industrial Computing). This technical standard, introduced at the Embedded Systems Conference in April 2004, has quickly gained in popularity and design wins. In January 2005, the PC/104 Consortium voted in favor of adopting and managing the EPIC technical standard in addition to PC/104 and EBX.

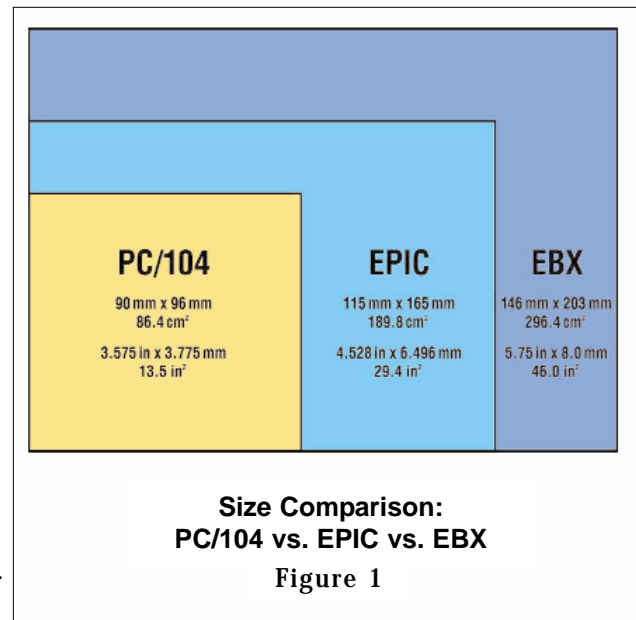
EPIC is defined as an expandable platform whose size is almost halfway between PC/104 and EBX (Figure 1). A PC/104 module has 86.4 cm<sup>2</sup> (13.4 in<sup>2</sup>) of area while an EBX board has 296 cm<sup>2</sup> (46 in<sup>2</sup>) of area. The midpoint between EBX and PC/104 is 191.2 cm<sup>2</sup> (29.7 in<sup>2</sup>). EPIC's size is 190 cm<sup>2</sup> (29.3 in<sup>2</sup>), and Figure 1 shows the relative size of PC/104 vs. EPIC vs.

EBX. All three platforms serve in deeply embedded applications where long-term availability and high reliability are crucial. Even though they are similar, there are reasons for selecting one over the others: with size and system requirements at the top of the list

### An EPIC Choice

A PC/104 board supports a processor and basic I/O. Also included are PC/104 and PC/104-Plus (a version of PC/104 that adds a PCI bus) connectors that can take up to 15% of the available board area. As the power and integration of the CPU increases, it becomes difficult to provide all the power supplies, cooling, memory and I/O connectors on a single board. There simply is not

enough room to easily place the latest generation CPU on the board without making some difficult and often costly compromises. An EBX board is about 3-1/2 times as large as PC/104. With this much room it is possible to support the latest Pentium 4 processor and its accompanying memory and I/O. EBX boards can offer a full complement



of serial, parallel, USB, networking, video, audio, digital I/O and solid-state disk storage on a single board. However, EBX's increased real estate can make it unsuitable for space-constrained applications, or too costly since the designer may not need all the features available on the board. Conversely, an equivalent PC/104 solution may take three or four boards if it can even be done at all. This is where EPIC belongs, in between and complementary to PC/104 and EBX.

Larger than the compact PC/104 bus, the EPIC single board computer provides room for advanced processors or complex I/O functions for data acquisition, field wiring termination, I/O circuit protection, video processing, telecommunications,

networking, motion control, power supplies and other specialty functions. The EPIC specification allows I/O connections to be implemented as either pin-headers or PC-style "real-world" connectors. The standard provides specific I/O zones to implement functions such as Ethernet, serial ports, digital and analog I/O, video, wireless and various application-specific interfaces.

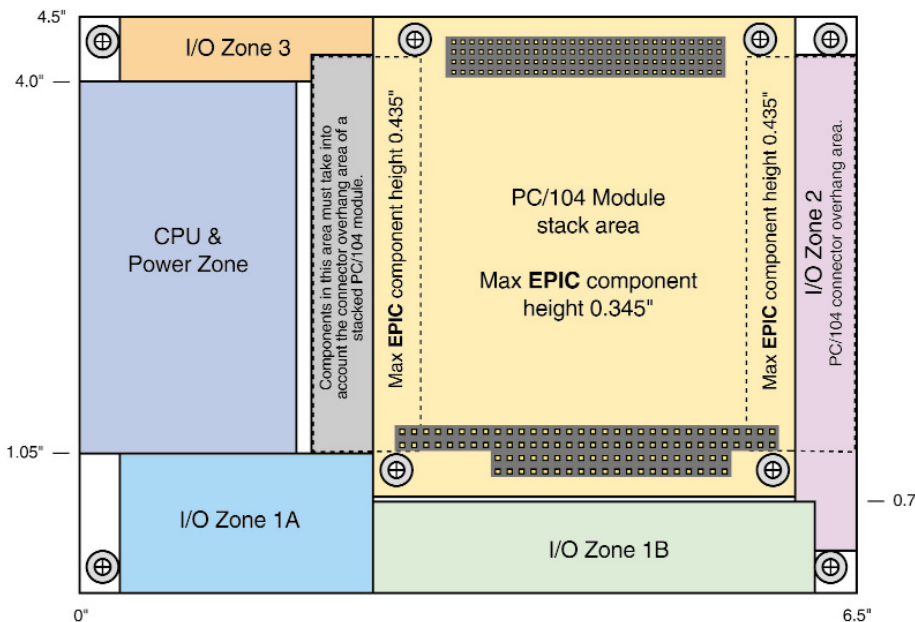
than 1,000 PC/104 and PC/104-Plus-compliant I/O expansion modules. This assures embedded systems designers long-term availability, expansion and support. Future phases of the EPIC standard will support new bus technologies moving into the embedded domain such as PCI Express, while maintaining consistency in footprint and mounting hole placement.

EPIC provides specific I/O zones, it does not prescribe what the I/O function or connectors should be. With this flexibility, it is possible to implement pin headers, PC-style or other I/O connector types as the application requirements may dictate. EPIC can support Ethernet, 802.11 wireless, video, general-purpose I/O, USB, Firewire and even has space available to support PCI Express and other future technologies as they migrate to the embedded market. These zones make EPIC extremely flexible.

Zone 1 is defined for I/O connectors and is split into Zone 1A and Zone 1B. The reason for two zones is connector depth allowed on board and potential height (z-axis) interference from PC/104 expansion modules. Zone 1A's depth extends to 1.05 inches to allow for deeper connectors such as currently exists for Ethernet, Compact-Flash, Express Card and certain large, stackable molded PC-type connectors. PC-type molded connectors permit standard I/O connectors to be mounted along a single edge of an EPIC SBC. Zone 1B's depth extends to 0.7 inches. It will support industry-standard 0.100-inch IDC type connectors, terminal blocks, USB and smaller, molded PC-type connectors. Pin headers and terminal blocks allow flexible cabling to application-specific boards or interfaces and remote peripherals.

Zone 2 is the second I/O zone located on the right side of the board. Typically pin header connectors would be used in this area since there is a potential height restriction of 0.6 inches due to a PC/104 module installed in the stack. Zone 3 is located in the upper left corner of EPIC and does not have a height restriction but its depth is 0.5 inches.

Another area without a height restriction is for a tall CPU and power dissipation. More powerful processors typically require a fan



EPIC measures 115 mm x 165 mm (4.5" x 6.5") and has various I/O zones defined for the the board.

Figure 2

### EPIC Supports I/O Expansion

One of the challenges of using small and mid-size SBCs is I/O support and expansion. It may be possible to squeeze a CPU plus peripheral functions on a single card, but room for connection and cabling becomes a major real estate issue. EPIC's strength is in its wide area available for I/O connectors as demanded by real-world applications. As shown in Figure 2, EPIC supports three different I/O zones plus additional expansion with PC/104 and PC/104-Plus modules. Even though

This is especially important for applications that cannot accommodate larger EBX-sized boards. And like PC/104 and EBX, EPIC expands modularly by using self-stacking PC/104 and PC/104-Plus expansion modules.

The EPIC standard is designed to reduce the confusion caused by the last few years' introduction of various mid-sized cards plagued with inconsistent connector and expansion schemes, and with no governing specifications (see sidebar: "EPIC Specification"). Phase one of the EPIC standard supports more

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and/or heatsink for proper cooling. This area reserves space for these items as well as the power connector. For deeply embedded applications, power requirements and connector configurations will differ. The location, specific connector, pin-out and current per pin for power to the EPIC is not defined; however, Appendix A of the EPIC specification provides two common examples.

One final area is defined for PC/104 and PC/104-*Plus* expansion connectors. This allows the modules to be placed in a stack if more I/O functions are required. Any circuits on the EPIC board in this area must conform to a height restriction of less than 0.345 inches to prevent interference from a PC/104 board. The orientation of the PC/104-*Plus* connector is the same as on EBX.

That means for many PC/104-*Plus* modules, the I/O connectors tend to

be on the right side of the board. The I/O connector placement on the module is not imperative, but reduces the potential for interference with the CPU fan/heatsink.

### Using EPIC; The Future

EPIC boards will be embedded directly into the product or an enclosure. Eight mounting holes are specified to allow an EPIC board to be securely fastened in a system. There are four mounting holes on each of the corners of the board plus the four PC/104 mounting holes. This allows the PC/104 stacked I/O modules to also be secured as well. PC/104 modules use four threaded standoffs that separate the boards as well as hold them together in a stack.

Serial fabrics like PCI Express and others are migrating from the desktop into embedded applications. A future revision of the EPIC specification

will define how advanced fabric support will be added. As of this writing, a future revision is only in the discussion phase and is not ready for integration into the EPIC specification. For more information about the technical specifications and application environment for EPIC boards, visit [www.epic-sbc.org](http://www.epic-sbc.org) or [www.pc104.org](http://www.pc104.org). The EPIC website also contains a white paper and FAQs that are available for download free of charge. Since EPIC is an open hardware standard, companies are able to define and build boards without licensing or royalty fees.

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