Choosing the appropriate PC/104 format

By Kristin Allen

PC/104 has developed into several closely related variants, including Embedded Board eXpandable (EBX) and Embedded Platform for Industrial Computing (EPIC). The following form factor rundown explores the history behind these SBCs and provides a guide to choosing between the formats.

The PC/104 family has grown significantly since the establishment of the PC/104 Embedded Consortium and the adoption of its first specification in 1992. Today PC/104 and its sibling products can be found in a dizzying array of applications ranging from piloting undersea exploration vehicles to guiding unmanned military aircraft.

These boards help students with robotics research and assist doctors with kidney dialysis and laser eye surgery procedures. PC/104 products may be found inside a volcano crater monitoring earthquakes or under a weather balloon measuring climate changes. Security functions include baggage inspection and chemical and radiation detection systems. Transportation uses range from data processing in what is purported to be the world's fastest electric vehicle to battery management in electric commuter cars. The boards can control entertainment applications ranging from casino gaming machines to theatrical lighting. Other applications range from maximizing quality and production on a farm to calibrating compasses on military aircraft. The range of uses for PC/104 boards and systems, such as those shown in Figure 1, are endless.

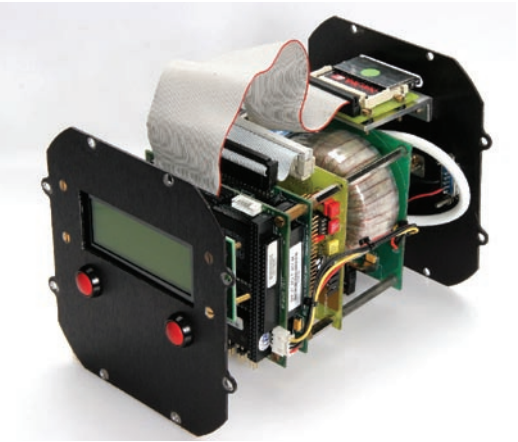

Figure 1

The PC/104 family includes more than just the original 3.6" x 3.8" embedded computing standard. PC/104 defines a physical shape and a family of expansion buses for compact, low-cost applications. The family of products presently consists of three different form factors – PC/104, EBX, and EPIC – and five different configurations – PC/104, PC/104-*Plus*, PCI-104, EBX, and EPIC.

The PC/104 specification was originally developed as an expansion method for adding I/O to larger footprint embedded computers. Later, PC/104 CPUs were introduced. Today, more than 100 companies around the world offer CPUs, I/O boards, packaging, and accessories for PC/104, creating a healthy industry that provides a wide array of choices for embedded systems designers. Because so many companies offer compatible PC/104 boards and accessories, PC/104 provides a reliable platform for embedded systems designers concerned with long product life and features availability. Designers can mix and match boards from multiple vendors and upgrade processors and I/O to achieve higher performance and new requirements as needed.

The heart of PC/104 is its stacked-board design. The expansion buses are implemented using pin-and-socket connectors that enable boards to plug directly on top of each other. This creates a rugged, backplaneless method of building an embedded system from board-level components. Boards are held together with a rigid four-corner mounting system, resulting in an extremely rigid multiboard system. Because PC/104 can withstand shock and vibration, it is particularly popular in vehicle and military applications.

Comparing family members

Each SBC in the PC/104 family is capable of either stand-alone or stacked operation. Each SBC stands out for its long-term availability and high-reliability operation. So what are the differences, and why choose one over the other? While the available physical space and system requirements often drive this decision, the target application, maintenance concerns, and operating temperature range also play a role in the process. Table 1 compares several selection factors.

PC/104 was originally released in 1992 in response to a need for a compact version of the PC bus that would accommodate the reduced space and power constraints in embedded control applications. Yet these goals had to be realized without sacrificing full hardware and software compatibility with the popular PC bus standard. This would allow designers to fully leverage PC hardware, software, development tools, and system design knowledge. PC/104 addresses this need, offering full architecture, hardware, and software compatibility with the PC bus in a compact 3.6" x 3.8" (91.44 mm x 96.52 mm) size. The name was derived from the PC compatibility and the 104-pin ISA bus connector located on the lower edge of the board.

***PC/104*-Plus** added the 120-pin PCI bus to the upper edge of the PC/104 board in 1997. This change allowed the use of PCI-compatible I/O such as video, audio, Ethernet, and contemporary communications. Legacy PC/104 (ISA-only) modules can coexist in a stack along with the PCI-enabled modules, provided the legacy modules are on top.

PCI-104, added in 2004, removed the ISA bus from the PC/104-*Plus* board, leaving only the 120-pin PCI bus on the board's upper edge. Eliminating the large ISA bus connector provides an additional 10 percent of board area for larger CPU chipsets, higher levels of integration, and I/O connectors. One benefit of the PCI-only format is processor independence. While ISA is primarily used as an x86 expansion bus in PC-compatible systems, PCI can be used with other processor architectures including XScale, PowerPC, and ARM, as well as FPGAs.

Form Factor	Smallest size	Lowest maintenance time	Accommodates fastest processors	PCI expansion	Lowest system cost	Lowest upgrade cost
PC/104	X					X
PC/104-*Plus*	X			X		X
PCI-104	X			X		X
EBX		X	X	X	X	
EPIC		X	X	X	X	

Table 1

EBX became a standard in 2005, with the original specification dating back to 1997. This larger 5.75" x 8.00" (146 mm x 203 mm) SBC with PC/104-*Plus* expansion was introduced to include more circuitry on a single board, thereby reducing the number of boards in a system. Though larger than the PC/104 standard, it is more compact than the smallest commercial motherboard standards. Nearly a dozen vendors offer EBX form factor SBCs today in addition to the hundreds of PC/104, PC/104-*Plus*, and PCI-104 boards.

EPIC was adopted in 2005 to meet the need for an intermediate-sized form factor midway between PC/104 and EBX. EPIC, at 6.5" x 4.5" (165 mm x 115 mm), provides more room for the latest processor chipsets while retaining a relatively small size. It allows I/O to be implemented with either common pin headers or PC-style (real-world) connectors. The standard also defines specific I/O zones to implement functions such as Ethernet, serial ports, digital and analog I/O, video, wireless, and various application-specific interfaces.

Making the choice

While all three form factors (PC/104, EPIC, and EBX) are based on the same IEEE P996 and PCI standards, they differ primarily in terms of size. The extra space is critical when implementing the latest processors and chipsets. Figure 2 shows each board's relative footprint. The EBX form factor is almost 3.5 times the size of PC/104, and EPIC offers more than twice the available board space for components.

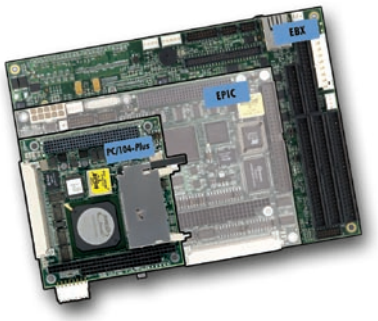

Figure 2

Because they can accommodate more functions on a single board, a single board EBX and EPIC system will typically result in a higher-performance, lower-cost, and more rugged solution than a stack of PC/104 modules. When additional modules are required, factors such as PCB materials, extra connectors, and additional assembly costs increase the system cost. On the other hand, PC/104 may be the only form factor that fits into a space-constrained application.

Another factor affecting the selection decision will be system maintenance. It may be more difficult to service or replace a module in the middle of a stack of multiple PC/104 boards than to service a single EBX or EPIC board. However, upgrading a single I/O module will be less costly than replacing an entire EBX or EPIC board.

A system designer also must take into account how rugged the system needs to be. For a system with a number of I/O modules, a properly housed stand-alone PC/104 stack is typically the most rugged option. Several vendors provide ruggedized enclosures that protect against shock, vibration, and the elements. Getting the same ruggedness out of a module stacked atop an EBX or EPIC board requires a specially designed custom enclosure.

One size does not fit all

The PC/104, EBX, and EPIC form factors give embedded systems designers a variety of options so they can choose the one that best fits their needs and take advantage of the low-cost, stacking PC/104 architecture for I/O expansion. Designers likely will find compelling reasons to select one platform over the other, typically related to available space, total cost, and system requirements. Because one size does not fit all in the varied world of embedded computing, designers are fortunate to have a wide selection of products from which to choose. ➤

Kristin Allen *conducts marketing communications consulting, writing, and graphic design, specializing in the embedded computer industry. She holds an MBA from the University of Oregon and has 10 years of experience marketing embedded computers.*

To learn more, contact Kristin at:

Kristin Allen Marketing & Design
816 E. Avenue G
Port Aransas, TX 78373
541-914-6248
kristin@allenmarketingdesign.com
www.allenmarketingdesign.com

TECHNICAL DIRECTOR

Consortium seeks technical director

The PC/104 Embedded Consortium consists of members worldwide who have joined together to disseminate information about PC/104 and provide a liaison function between PC/104 and standards organizations. Members help shape the future of embedded market standards and gain early access to new developments in the industry.

The consortium is presently accepting applications for a technical director to help guide the consortium and interface with other industry associations and key players.

PC/104 Embedded Consortium
505 Beach Street, Suite 130
San Francisco, CA 94133
Tel: 415-674-4504
Fax: 415-674-4539
info@pc104.org
www.pc104.org