Features of the StackableUSB interface

A new specification for I/O expansion in embedded PCs

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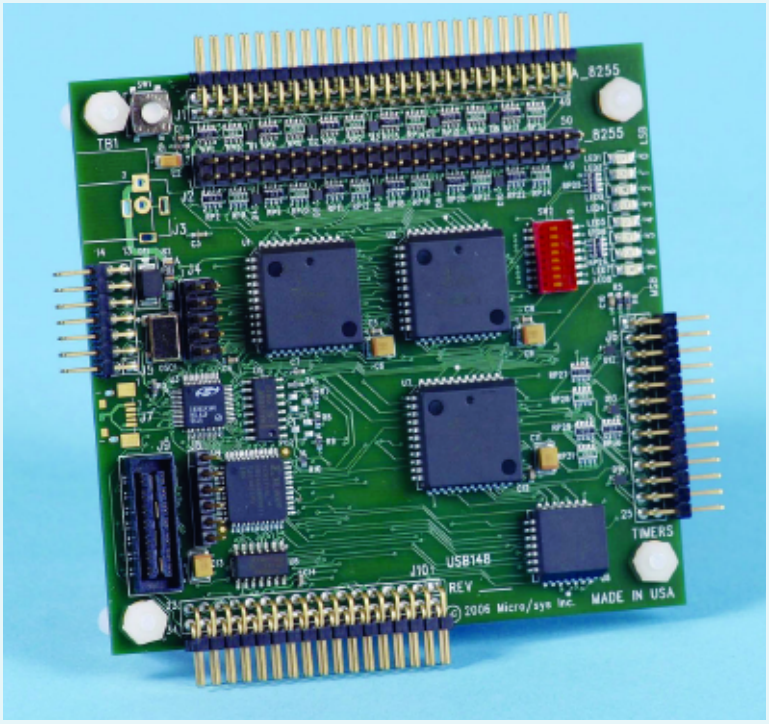
While the ISA bus and PC/104 continue to be popular, board-level embedded system designers are faced with the challenge of finding a replacement that can support current form factors and address demand for faster board-to-board communication. Technology from the desktop world has often evolved into embedded board-level products, for example, the evolution of StackableUSB developed by Micro/sys.

Using PC expansion buses for embedded systems

The desktop PC world has provided the foundation for many of the popular embeddable buses for I/O expansion, including the USB, PCI, PCIe, and standard ISA buses. Two advantages of these are widespread support from chip vendors, and software support in the form of drivers for popular operating systems. This encourages peripheral board manufacturers to offer expansion boards for these PC buses. However, these manufacturers' products are not always suitable for embedded applications.

Designers of embedded systems benefit from single-board computers that include stackable bus interfaces that allow flexibility in their design. This flexibility may be used to extend the lifetime of the system by providing multiple system configurations, or it may provide a means for adding new options, or innovations for system growth in the future.

Historically, PC/104, one of the more popular form factors, has provided these advantages. However, as the ISA bus interface—which is at the core of PC/104—is eliminated from PC chipsets, PC/104 is becoming more difficult and costly to implement. Some have looked to PCI and PCI Express as a successor, but these protocols are proving to be too costly or difficult to implement. This is where USB steps in and offers a solution called StackableUSB.



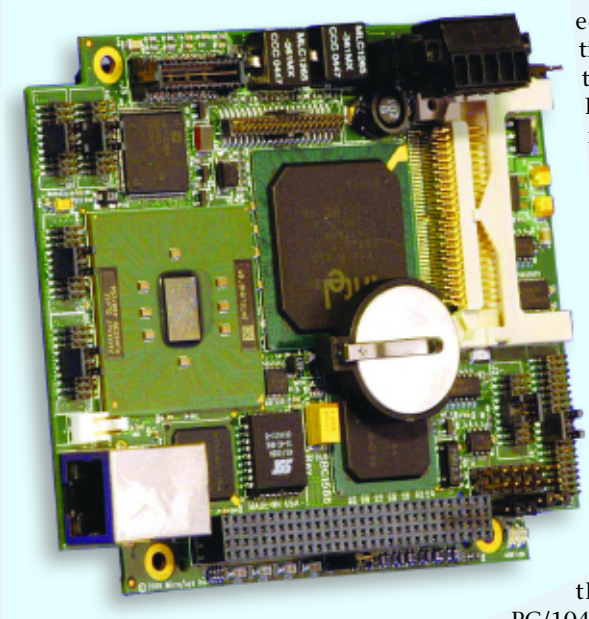
The USB148 is an example of a StackableUSB high-density digital I/O and timer card.

USB goes embedded with new features

StackableUSB, introduced earlier this year by Micro/sys, ruggedizes USB by eliminating the interconnecting cable that is common in the PC environment and typically considered a reliability risk in embedded applications. To eliminate this problem, StackableUSB specifies a small, stackable connector and defines a pin-out whereby multiple boards can communicate via the USB protocol. An embedded PC CPU board stacks together with the peripheral I/O card(s) onto either the top and/or bottom of the embedded PC, creating a mechanically rugged and physically compact set of boards.

Depending on the embedded PC, a CPU supports up to a total of 16 peripheral I/O cards, 8 on top and 8 on bottom, without the use of a hub board. With hub cards, the number of I/O cards that can be supported climbs to 76. The routing of the USB signals maintains a point-to-point connection for all devices up or down the stack and preserves the star topology for which USB is known.

Another enhancement is increased power for the peripheral I/O boards in the stack. By running power through the USB connector, the desktop limitation of 500 mA per I/O boards is increased to almost 1 A, reducing the need for separate



The SBC1685 is the industry's first StackableUSB host single-board computer.

power sources. The stack also has 5.0 V and 3.3 V available and provides an I^2C bus and a system reset signal. The StackableUSB specification is ideal for implementation on several embedded form factors including PC/104, EPIC, EBX, miniITX, COM Express, and ETX.

Advantages of StackableUSB for embedded apps

USB is easy to use, cost effective to implement, has high throughput, supports power management, has a low pin count, and brings a bright roadmap for long term support.

When boards are plugged into the stack, they are automatically detected, easing system integration issues. The software interfaces are straightforward. Designers can also easily implement custom I/O boards, an advantage PC/104 has offered for years but that PCI and PCI Express have not been able to provide. An abundance of USB interface chips make design easy, and many of the chips include some of the more common control functions that users of embedded systems need.

StackableUSB 2.0 has faster throughput rates than other buses such as PC/104. In "high-speed" mode, it runs at 480 Mbits/s per link, compared to 64 Mbits/s shared among all the boards in a stack with PC/104. This fast throughput is accomplished with only six connection points, compared to the ISA counterpart, PC/104, which uses 104 points in a parallel fashion. The popularity of USB is readily apparent by the wealth of data acquisition boards available today for desktop applications.

Embedded applications, in which power consumption is often a concern, will benefit from the StackableUSB feature that allows boards to be placed in a low-power mode when not being used by the system. While some more mature buses, such as PC/104, are facing obsolescence in many chipsets, USB is widely available in chipsets and will be on the roadmap for years to come.

StackableUSB serves all markets

USB I/O devices that have targeted the control market have typically been limited to the instrumentation and desktop market because the boards had to be connected to a desktop PC using a cable and mounted outside the PC enclosure. These devices, because of the packaging and logistic issues, have not always been attractive to OEM users, many of whom are using single-board computers.

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StackableUSB opens up opportunities in industrial control systems, mobile, handheld, military, medical, and remote communications applications by providing rugged, reliable connection solutions. It brings a wealth of benefits and enhancements to the embedded system design table. ■