PC/104 Embedded Consortium

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What is PCI/104-Express™?

Introduction

The PCI/104-Express specification establishes a standard to use high speed PCI Express® bus in embedded applications. It was developed by the PC/104 Embedded Consortium and adopted by member vote in March 2008. The PC/104 Consortium chose PCI Express® because of its full PC market adoption, performance, scalability, and growing silicon availability worldwide. It provides a new high-performance physical interface while retaining software compatibility with existing PCI infrastructure.

EPIC-Express and EBX-Express are the embodiments of PCI/104-Express on the PC/104 Embedded Consortium's EPIC and EBX form factors.

Incorporating the PCI Express bus within the industry proven PC/104 architecture brings many advantages for embedded applications including fast data transfer, low cost due to PC/104's unique self-stacking bus, high reliability due to PC/104's inherent ruggedness, and long term sustainability.

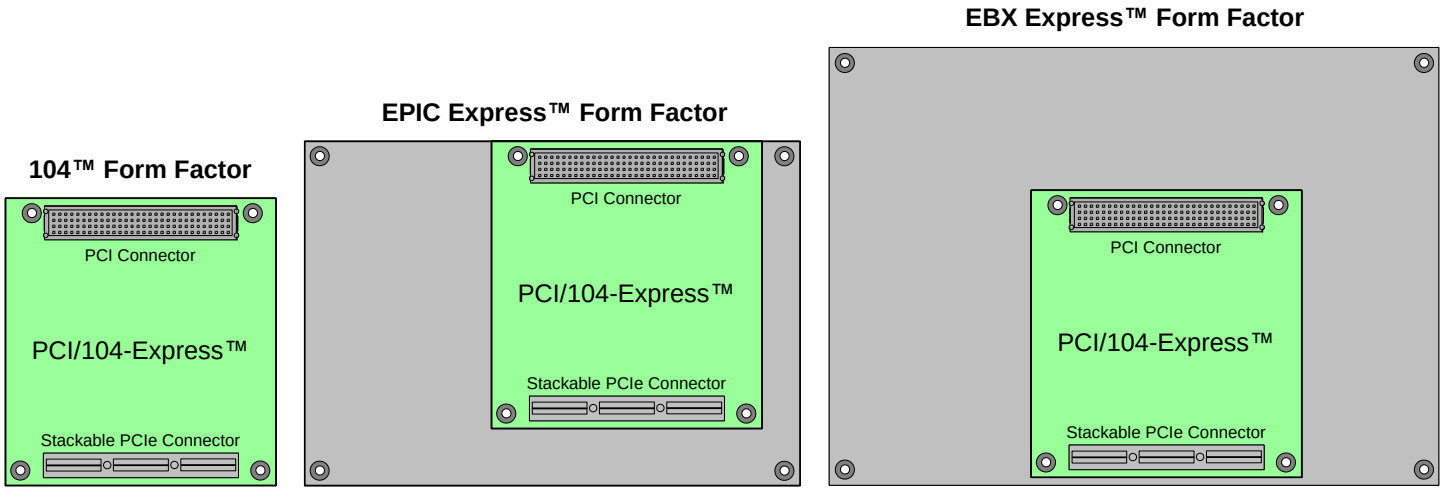
Background

The main objective in defining an addition of PCI Express to PC/104 was to preserve the attributes that have made PC/104 so successful in embedded applications, namely:

- Compact — 3.6 by 3.8 inches (90 x 96 mm) module size
- Self-stacking — expands without backplanes or card cages
- Rugged, reliable connectors — reliable in harsh environments
- Four-corner mounting holes — resistance to shock and vibration
- Fully PC compatible — reduced development costs and time-to-market

In addition, it was important that a stackable form of PCI Express take into consideration backward compatibility with current PC/104 Embedded Consortium specifications and form factors. The design had to support automatic detection of up or down stacking and had to have automatic link shifting to allow simplified, universal add-on module designs.

The PCI/104-Express design approach provides a consistent and interchangeable path for the stackable PC architecture across the PC/104 Embedded Consortium's 104, EPIC, and EBX form factors.



PCI/104-Express Specification Overview

There are two versions of PCIe/104 that are complementary. The main difference is that Type 2 replaces the PCI Express x16 link with SATA, USB 3.0, LPC, and RTC battery.

Both PCIe/104 Type 1 and Type 2 have this common feature set and pin assignments:

- Four x1 PCI Express Links
- Two USB 2.0
- ATX power and control signals: +5V Standby, Power supply on, Power OK
- Power: +3.3V, +5V, +12V
- SMBus

Type 1 has the common feature set plus:

- One x16 PCI Express Link, or optionally two x8 Links, two x4 PCI Express Links, or two SDVO

Type 2 has the common feature set plus:

- Two x4 PCI Express Links
- Two USB 3.0
- Two SATA
- LPC Bus
- RTC Battery

Feature	Type 1	Type 2
USB 2.0	2	2
SMB	1	1
PCIe x1	4	4
PCIe x4	2	2
PCIE x16	1	
USB 3.0		2
SATA		2
LPC		1
RTC Battery		1

Type 1 and Type 2 stacking rules explained

1. Any PCI Express x1, PCI Express x4, or USB 2.0 peripheral is universal and can plug into either Type 1 or Type 2.
2. All PCI Express x16 peripherals must plug into Type 1.
3. All SATA, USB 3.0, and LPC peripherals must plug into Type 2.
4. Anything plugged in the wrong bus holds the system in reset and causes no damage.

PCI-104 PCI Bus connector

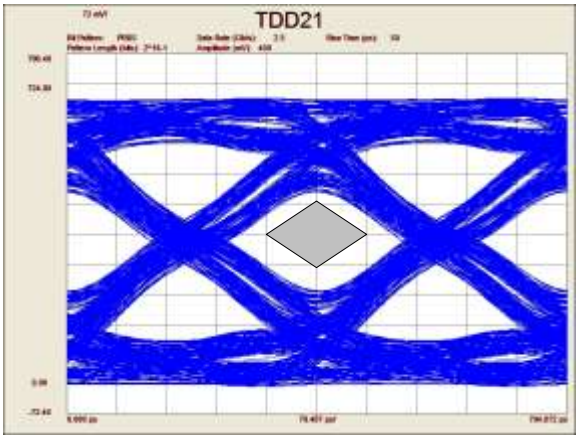
- PCI Bus: 32-bit, 33 MHz, Four Bus Master capable (same as on PC/104-*Plus* and & PCI-104)
- Power: +3.3V, +5V, +12V, -12V, +5V Standby, Power Supply On, and PME for ATX power supply

PCI/104-Express Connector

The PCI Express connector was specifically designed for the PC/104 Embedded Consortium to match the PC/104 standard 0.600 inch (15.24mm) stacking height and standoff tolerances. It was then tested to ensure it meets the PC/104 durability expectations and PCI Express signal integrity requirements. A 0.866 inch (22.00mm) version is also specified.

PCI Express Top Connector

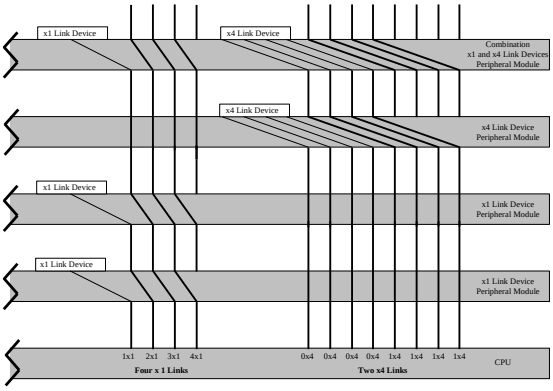
PCI Express Bottom Connector



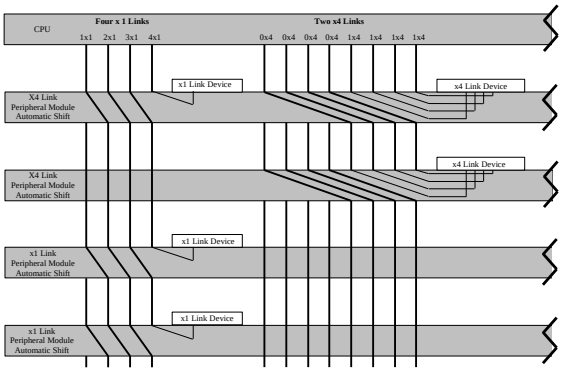
Signal Integrity Test Result

Link Shifting Stack Examples

Link shifting allows universal add-in card design and automatic PCI Express link assignment.



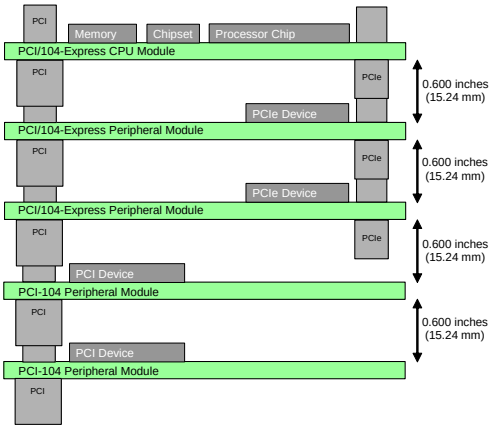
Automatic Link Shifting Stack-Up Example



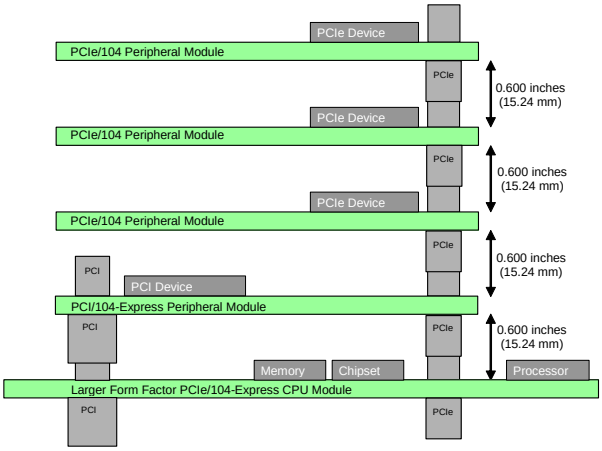
Automatic Link Shifting Stack-Down Example

Up or Down Stack Configuration Examples

The flexibility and expandability of the bus and mechanical layout allow many different stack configurations to support an array of diverse project requirements. See full specification for more examples.



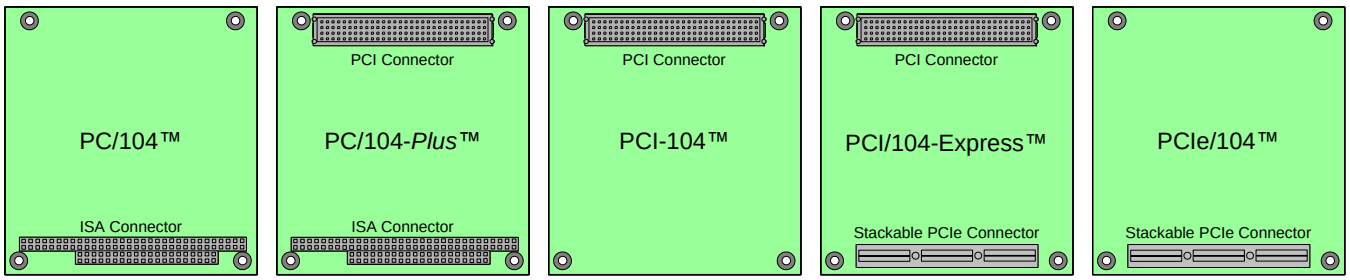
Stack-DOWN Configuration Example



Stack-UP Configuration Example with Large Form Factor Host Baseboard

PC/104 Bus Evolution

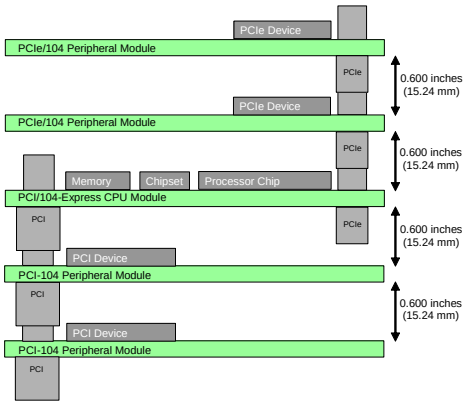
PC/104 stackable embedded PCs have followed the desktop PC leveraging on the hardware and software support developed for this popular platform.



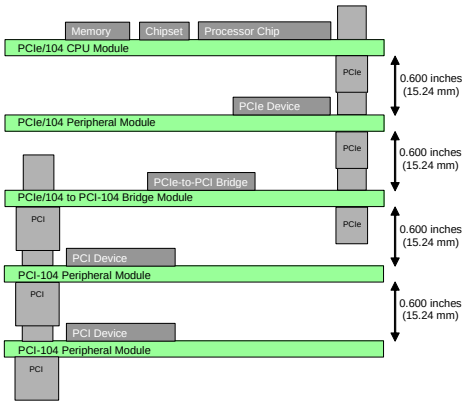
ISA Bus | **ISA and PCI Bus** | **PCI™ Bus** | **PCI and PCIe Bus** | **PCIe® Bus**

PCIe/104™

PCIe/104 is PCI/104-Express without the PCI bus. Since PCI Express is based on PCI technology, a PCI Express to PCI Bridge is straightforward. A comparison between a PCI/104-Express CPU and Stack and a PCIe/104 CPU and stack shows that both easily support PCI Express and PCI add-in cards.



PCI/104-Express CPU with PCIe/104 stack up and PCI stack down



PCIe/104 with PCIe/104 to PCI Bridge

Current Status of the PCI/104-Express Standard

The specification was adopted by PC/104 Embedded Consortium member vote in March 2008. Version 2.0 was approved by member vote on February 9, 2011. Numerous companies have announced development and support for PCI/104-Express. Products demonstrated or under development include high performance single-board computers, 1Gbit Ethernet, high performance data acquisition and control interfaces, PCI bus adapters and bridges, and packet switches to provide expansion beyond 6 add-in cards.

Copies of the PCI/104-Express Specification are available to individuals and companies developing embedded systems. For further information, contact the PC/104 Embedded Consortium at www.pc104.org.

Other PC/104 Specifications

The PC/104 Embedded Consortium maintains the PC/104™, PC/104-*Plus*™, and PCI-104™ specifications on the 104™ form factor as well as the specifications for the EPIC™ and EBX™ form factors.

PC/104 is the original specification. It defined the 104 form factor at 3.550 x 3.775 inch (90.17 x 95.89 mm) with a stacking ISA bus. There are 8-bit (XT) and a 16-bit (AT) versions.

PC/104-*Plus* added PCI bus to classic PC/104 on the 104 form factor. 132M Bytes per second transfer rate made high speed processing possible in rugged embedded systems while the ISA bus allowed use of the extensive infrastructure of embedded modules.

PCI-104 actually existed in the PC/104-*Plus* specification, but it didn't have a name. Instead of calling it "PC/104-*Plus* PCI only" forever, the consortium decided to give it its own specification and PCI-104 was born with only a PCI bus on the 104 form factor.

While not much new was happening in PC bus architecture, the consortium adopted two form factor specifications.

EPIC and EPIC Express (Embedded Platform for Industrial Computing) was the first to be introduced. At 4.528 x 6.496 inches (115.00 x 165.00 mm), it is larger than the 104 form factor and allows room for tall cooling solutions for high end processors and space for standard PC style I/O connectors.

EBX and EBX Express (Embedded Board, eXpandable) is the original 5¼ inch form factor of many single board computers. At 5.750 x 8.000 inches (146.05 x 203.20 mm) it has room for a complete computer with standard I/O and memory DIMMs but still features PC/104-*Plus* or PCI/104-Express expansion for flexibility and expandability.

Where Does PCI/104-Express Fit?

The PCI/104-Express & PCIe/104 specifications continue to following the desktop PC and the path provided by the major chipset manufacturers.

- PC/104 supports ISA only
- PC/104-*Plus* supports PCI and ISA
- PCI-104 supports PCI only

And now

- PCI/104-Express supports PCI Express and PCI
- PCIe/104 supports PCI Express only

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