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Leading EDGE COMPUTING

Technical Article

Stackable PC/104 Set to Raise the Game in Industrial System Design

With PCI/104-Express, the time-tested evolution of PC/104 has entered a new phase with powerful processors and high-speed I/Os and is now ready to serve today's transportation and industrial applications.

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PC/104 true ruggedness by design for extreme harsh environments

PC/104, a major standard in the embedded market, is playing a crucial role in industrial system upgrades that usually require five to 10 times more performance than traditional PC/104 systems. At the same time, these system upgrades demand compact PC/104-size footprints while simultaneously aiming to lower power consumption.

The PC/104 form factor's unique stackable architecture ideally fits into the quickly changing industrial and embedded landscape where we see an exponential rise in the number of sensors and cameras in heavy trucks, forklifts, and industrial robots, especially in applications that mandate rapid prototyping, development, and uptime.

PC/104 is a small-form-factor, stackable board standard that helps designers create a truly embedded compute system with the rugged and compact features of the past combined with the most current technologies. And if you need additional functionality at a later stage, all you have to do is add another board to the stack.

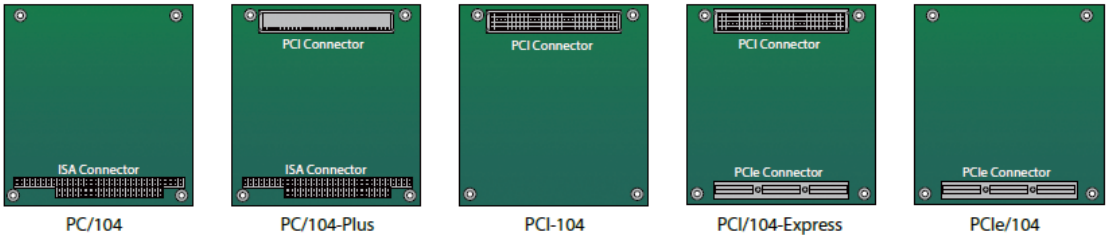


Image: A continuous increase in compute power and evolving bus support within a small package sums up the progression of PC/104-based embedded systems. (Image: PC/104 Consortium)

Another notable design trend favoring PC/104-based embedded systems is the need to process data locally and store it on rugged storage devices. While some industrial applications — performing monitoring, tracking, and processing tasks — send the data to the cloud, others require local processing and analysis for mission-critical operations. In the latter case, PC/104 brings high-speed processing plus graphics and peripheral capabilities via stackable boards at a relatively low cost. In other words, the ability to mix and match functionality with CPU and peripheral boards creates a universal add-on modular design.

PC/104 in industrial applications

Having long been a staple of unarmed aerial vehicle (UAV) avionics, PC/104 hardware has recently become popular in next-generation transportation and industrial applications. This is partly a due to PC/104 being able to meet stringent environmental and thermal requirements. Another factor is the configurability and reliability that is critical in industrial environments. PC/104's stackable modules enable the simple construction of miniature systems that boast flexible configuration and a wide array of interface options, and are ideal for the next-generation of industrial and embedded systems that encompass wide-ranging tasks and variables, and require greater I/O flexibility to accommodate an increasing number of cameras and sensors.

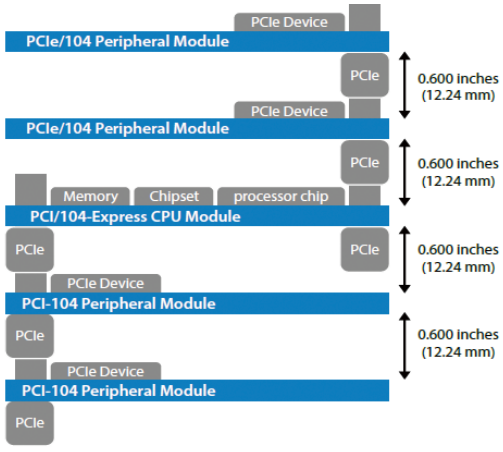
PC/104 hardware is highly suitable for heavy equipment applications including those in construction and mining environments that use unregulated power and are vulnerable to dirt and dust. Moreover, these outdoor applications are subject to extreme temperatures, rain, humidity, and salt.

However, the key to many heavy equipment applications is a flexible I/O architecture, coupled with sufficient processing power for computation and improved memory bandwidth. Intensive imaging and DSP resources are required to process the data from the numerous cameras and sensors on these heavy-equipment devices.

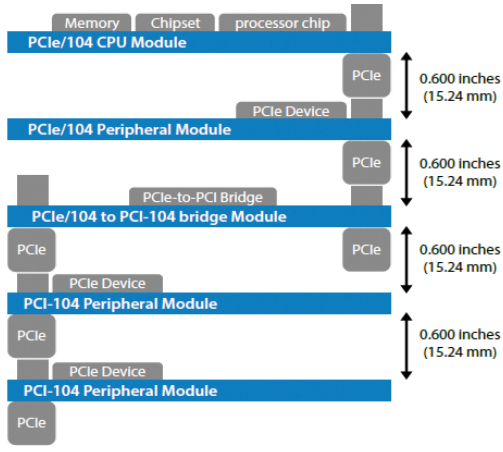
These industrial applications require high-bandwidth buses for data transfer to and from the single-board computer (SBC) so they can efficiently utilize high-speed PCI Express (PCIe) links. The flexibility of a self-stacking form factor not requiring a backplane allows industrial OEMs to better focus on thermal management requirements for their specific applications. With products known for long lifecycles, the PC/104 family's stackable ISA, PCI, and PCIe bus connectors can serve a wide array of industrial environments such as transportation, railway, mining, power plants and manufacturing. This brings us to what's new in PC/104's otherwise mature technology landscape.

The PCI Express renaissance

PC/104 isn't a new technology. What's new is its ability to marry multicore processors and extreme graphics performance with I/O scalability. For a start, embedded applications can incorporate the PCIe bus with the PCI/104-Express specification, which incorporates PCIe in addition to the PCI bus. The industry-proven PC/104 architecture allows system design and integration at a lower cost due to its self-stacking capabilities and compatibility between bus structures. PCI/104-Express support for newer high-speed interfaces such as PCIe, USB, SATA and Gigabit Ethernet allows easy integration of next-generation I/O peripherals .



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



PCIe/104 with PCIe/104 to PCI Bridge

Image: An example of a PCI/104-Express SBC with PCIe/104 stack up and PCI stack down.

The PCI/104-Express specification with its choice of PCI Express connector chosen for high signal integrity makes I/O integration straightforward by eliminating the need for additional engineering work to implement peripheral expansion. In addition, the I/O upgrade to PCIe is accompanied by the high reliability of PC/104's inherent ruggedness and long-term sustainability.

The I/O renaissance in PC/104 modules is intertwined with the availability of advanced CPUs that bring higher levels of compute and graphics performance along with multiple display outputs. Processors are also becoming smaller and smaller, leaving more board real estate for design layout. Combine the high-speed connectivity of PCI/104-Express with ever-more powerful and energy efficient processors and fast DDR4 memory in PC/104's stackable form factor and mature ecosystem and what you have is a unique architecture that is able to meet the industrial environment rigors at the bottom of oceans, in the middle of sand storms, or on top of Arctic icecaps.

PCI/104-Express boards

An excellent implementation of powerful processing and high-speed I/O in a PC/104 module is the ADLINK CMx-SLx PCI/104-Express Type 1 single board computer, based on the 64-bit 6th generation Intel® Core™ i3 processor (formerly "Skylake H"). The CMx-SLx is specifically designed for customers who need high-level processing and graphics performance in a long product life solution and leverages Intel® HD Graphics and DDR4 memory for optimum graphics and I/O performance for today's video-intensive data traffic applications.

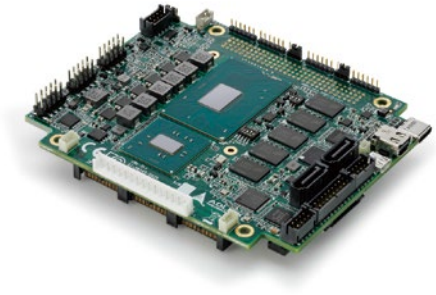
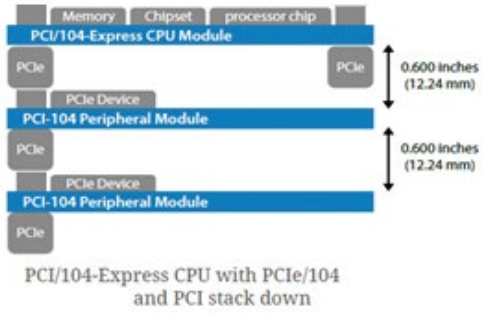


Image: The CMx-SLx PCI/104-Express Type 1 single board computer can process data locally as well as connect legacy industrial devices to the cloud.



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

Image: PCI/104-Express stack-down

PC/104 with a new fervor

The PC/104 standard, based on a stackable and modular bus architecture, has come a long way since its humble beginnings in 1992. This rugged and reliable form factor with its family of specifications covering a wide range of bus architectures and I/O has proven itself in applications on land, sea, and air. Fast forward to 2017, and its longevity combined with the ability to embrace the latest technologies is keeping it relevant in a number of electronic design realms, including heavy-equipment industrial applications. PC/104, known for a timely evolution path, is ready to serve embedded systems with a new fervor at a time when initiatives like Industry 4.0 and industrial IoT are reinvigorating the electronic design landscape.

About ADLINK

ADLINK Technology is leading edge computing with solutions that drive data-to-decision applications across industries. ADLINK offers building blocks and generic and market-specific IIoT platforms to serve the automation, communications, medical, transportation, and defense/ government verticals. Our products include motherboards, blades, chassis, modules, gateways, systems and end-to-end solutions based on industry standard form factors, as well as test & measurement products and smart touch computers, displays and handhelds that support the global transition to always connected systems. ADLINK is a Premier Member of the Intel® Internet of Things Solutions Alliance and is active in several standards organizations and interoperability initiatives.

intel IoT Solutions Alliance Premier

Appendix: PC/104 Series Selection Guide

Product Name	CMx-SLx	CM3-BT4	CM2-BT2
CPU	Intel® Core™ i3-6102E Intel® Xeon® E3-1505L v5	Intel® Atom™ E3845 SoC (quad core)	Intel® Atom™ E3825 SoC
Memory	Up to 16 GB soldered ECC DDR4	Up to 4 GB DDR3L SO-DIMM	Up to 4 GB DDR3L SO-DIMM
PATA/SATA	2x external SATA 6Gb/s 1x internal (SATA-SSD)	1x SATA 3Gb/s shared with mSATA (opt. 2nd SATA 3Gb/s port w/o mSATA support)	1x SATA 3Gb/s shared with mSATA (opt. 2nd SATA 3GB/s port w/o mSATA support)
Serial Port	2x RS-232	4x RS-232/485	4x RS-232/485
USB	1x USB 3.1 Gen 1 4x USB 2.0	3x USB 2.0	3x USB 2.0
GPIO	8	8	8
LAN	2x GbE	2x GbE	2x GbE
Operating Temperature	0°C to +60°C -40°C to +85°C (opt.)	0°C to +60°C -40°C to +85°C (opt.)	0°C to +60°C -40°C to +85°C (opt.)
OS support	Windows 10, Windows 7, Linux, VxWorks 7, QNX	Windows 7, Windows 8, WEC7, Linux, QNX, VxWorks	Windows 7, Windows 8, WEC7, Linux, QNX, VxWorks

Product Name	CM1-BT1	CM1-86DX3
CPU	Intel® Atom™ E3815 SoC	Vortex86DX3 SoC
Memory	Up to 4 GB DDR3L SO-DIMM	2 GB soldered DDR3L
PATA/SATA	1x SATA 3Gb/s shared with mSATA (opt. 2nd SATA 3Gb/s port w/o mSATA support)	1x SATA 1.5Gb/s (or CFast)
Serial Port	4x RS-232/485	2x RS-232 2x RS-232/422/485
USB	3x USB 2.0	2x USB 2.0
GPIO	8	8
LAN	2x GbE	1x GbE 1x 10/100 Mbit
Operating Temperature	0°C to +60°C -40°C to +85°C (opt.)	0°C to +60°C -40°C to +85°C (opt., contact for availability)
OS support	Windows 7, Windows 8, WEC7, Linux, QNX, VxWorks	WES2009, WES7, Linux, QNX on request: WEC7, Windows CE 6.0

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