CompactPCI cards for advanced avionics systems development

By Michael J. Randazzo, DDC

CompactPCI is a first choice for modernizing legacy test equipment or developing a new system. Its modular hardware design, wide range of COTS I/O options, good instrumentation control, and clear migration path to future technology make it a smart, cost-effective and flexible solution able to support avionics systems development for years to come.

Figure 1. Example of a CompactPCI chassis

■ The CompactPCI (cPCI) form factor has continued to allow avionics system designers to keep development costs low through the use of commercial off-the-shelf (COTS) products. It remains a very popular form factor choice for systems requiring multiple and modular I/O capabilities, specifically avionics protocols, such as MIL-STD-1553 and ARINC 429. In the defense/aerospace sector, some sample applications are system simulation/integration, production/automated test (ATP), portable test equipment, and rapid prototyping of custom hardware designs.

The cPCI specification was developed by the PCI Industrial Computer Manufacturers Group (PICMG) in the mid 1990s to incorporate PCI-based technology into industrial computers. It is electrically a superset of desktop PCI with a different physical form factor. CompactPCI leverages the Eurocard form factor, popularized by the VME bus, and supports both 3U (100mm x 160mm) and 6U (160mm x 233mm) card sizes. Though mainly used in lab environments, a conduction-cooled form factor variant exists to support harsh shock, vibration, and temperature conditions, while maintaining the same electrical PCI characteristics and signaling. Since cPCI uses a chassis rack-mountable backplane and is physically similar to VME, it was quickly adopted by the avionics community, which had been dominated by VME since the early 1980s. The cPCI form factor maintains core system requirements such as vertical card orientation, positive card retention, excellent shock and vibration characteristics, and front or rear I/O options. What really added to its appeal was the use of standard PCI silicon, which was already being manufactured in large volumes for use in the desktop computer marketplace. This greatly reduced the cost of manufacturing cPCI cards compared with VME cards. As VME designs become more difficult to manufacture and support, cPCI offers an ideal alternative to support the needs formerly handled by VME cards.

Once the test and measurement community started to adopt cPCI, it was clear that they needed more capability to meet timing and synchronization requirements across multiple devices. Previously, VME cards addressed this need with the VXI Bus enhancement. This resulted in the creation of the PXI (PCI eXtensions for Instrumentation) platform. The PXI platform added an additional optional connector to the already defined cPCI form factor. This connector enabled integrated timing and synchronization that is used to route synchronization clocks and triggers internally through the chassis backplane. Today, most test applications that previously would have required VME cards now rely on lower cost cPCI cards.

Data Device Corporation (DDC) provides CompactPCI/PXI cards for MIL-STD-1553/1760, ARINC 429, and synchro/resolver with many cards combining different types of I/O on one board to save even more power, space, weight, and cost. For example, the latest generation of Multi-IO CompactPCI/PXI cards BU-67107T would require only a single 3U card to support 4 dual-redundant MIL-STD-1553 channels, 8 ARINC-429 receivers, 4 ARINC-429 transmitters, 6 user-programmable digital discretes, 2 RS-232 channels, and 2 RS-422/485 channels. Using only single-IO solutions, an equivalent system would require 4 separate devices, greatly increasing the cost and installation time expended by system designers.

With respect to the MIL-STD-1553 protocol, DDC gives more control to the system designer, by offering two levels of functionality. Its latest 1553 generation, AceXtreme, now comes in single and multi-function configurations. The single-function configuration offers emulation of a bus controller (BC) or up to 31 remote terminals (RTs). Either mode can concurrently execute the bus monitor (MT), to capture all data on the bus. The multi-function configuration, targeted for test and simulation systems, adds the ability to concurrently run the BC, up to 31 RTs, and MT, and also includes the 1553 test and simulation toolkit. The toolkit

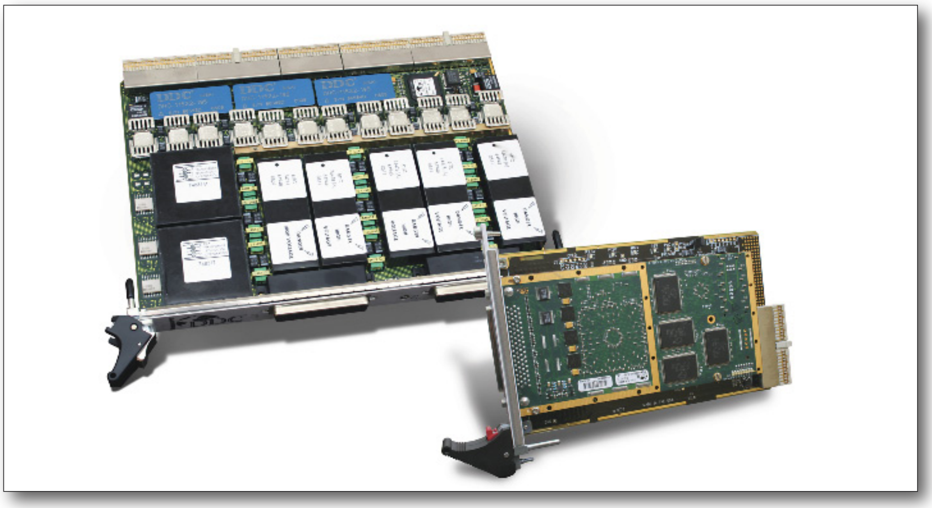

Figure 2. 6U (Synchro/Resolver) vs. 3U (MIL-STD-1553) CompactPCI cards

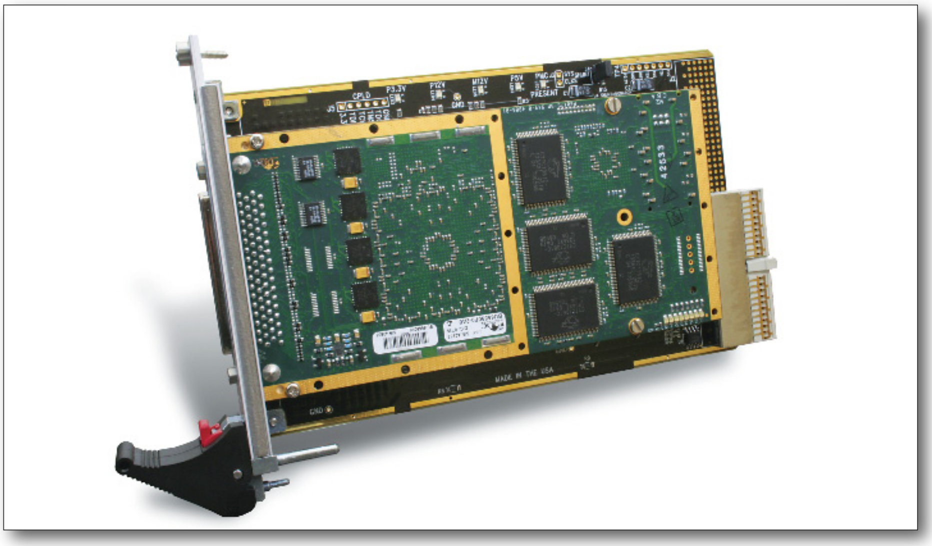

Figure 3. DDC Multi-IO MIL-STD-1553/ARINC-429 3U cPCI/PXI card

adds error injection, internal/external triggering, and the ability to test out-of-bounds 1553 parameters (such as intermessage gap). The BU-67210T 1553 multi-function series are 3U CompactPCI/PXI cards with up to 4 dual-redundant 1553 channels, 8 digital and 8 avionics-level discretes, and IRIG-B input/output.

Since it is relatively easy to assemble and procure a CompactPCI system with COTS hardware, it is a great choice for prototyping custom embedded systems. This allows system designers to configure a system with identical hardware and software functionality as the final system, except using the CompactPCI form factor. It also enables any software development to begin before initial prototype hardware is available so that the designer can address any system level concerns before mass production. All DDC software development kits (SDKs) for MIL-STD-1553 and ARINC-429 are hardware independent and have a common API. This enables software to be developed and tested using one form factor (such as cPCI), and reused in its entirety on a different form factor (such as PMC or component-level solution). Designers using this approach have benefited from shortened development schedules, less system troubleshooting, and avoiding costly board re-spins.

To simplify the software development process even further, DDC offers code generation capability with its BusTrACEr BU-69066S0 MIL-STD-1553 data bus analyzer. The tool allows the user to configure a 1553 bus controller, multiple remote terminals, and a bus monitor with an easy-to-use point-and-click graphical interface. Once the 1553 configuration is complete, a single click will generate ANSI C source code to duplicate the same configuration using DDC 1553 SDK. The generated source code then can be used with any operating system (Windows 2000/XP/Vista/7, Linux, VxWorks, etc.) and any DDC board or component, saving the designer many hours of additional programming time for the embedded system that would otherwise be required.

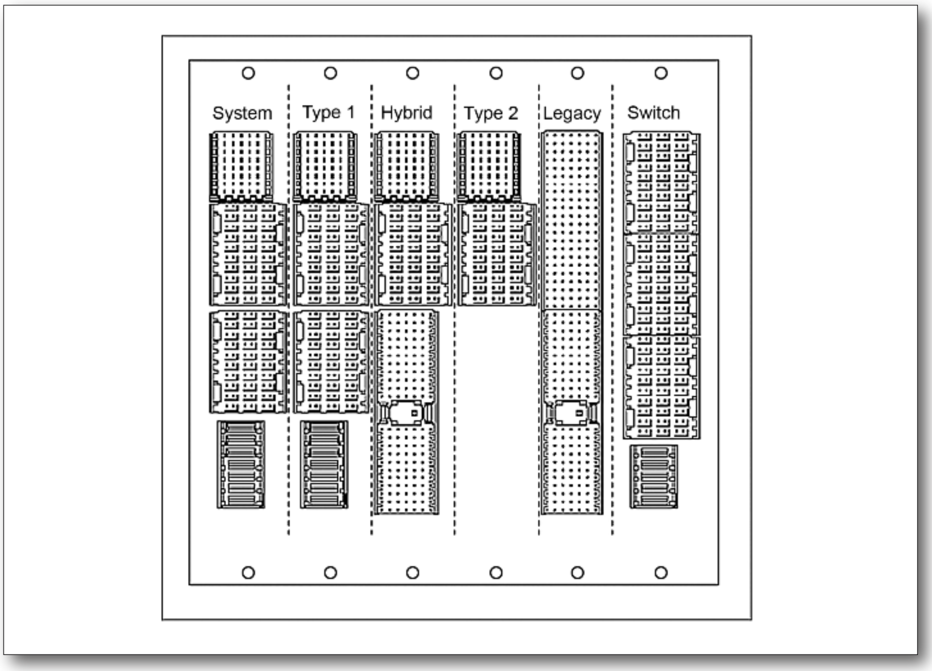

Figure 4. Hybrid cPCI/cPCI Express backplane

All CompactPCI/PXI systems require a CPU card or system controller. Following the COTS approach, there are many CPU vendors in the marketplace offering standard 3U and 6U controllers. A majority of these systems are x86-based, but other processor families, like PowerPC, can be procured. Since the controllers are based on standard processor architectures, cPCI systems designers have a wealth of choices regarding operating systems and programming environments. One environment that stands out as a leader in the cPCI/PXI community is the LabVIEW programming language. Short for laboratory virtual instrumentation engineering workbench, LabVIEW was developed by National Instruments in the 1980s as a visual programming language. Execution is determined by the use of a graphical block diagram on which the programmer connects different functions by drawing wires. The inherent parallel execution and multi-processing makes it a great fit for data acquisition, instrument control and test automation. Combined with extensive support for COTS hardware, a test system can be developed rather easily, without sacrificing capability. DDC LabVIEW support package BU-69093S0 enables developers to use LabVIEW to develop applications using MIL-STD-1553 and/or ARINC-429 protocols. To make development even easier, a collection of "Intermediate Vis" was created, which allow the user to quickly configure commonly used 1553/429 functionality. Combined with a DDC cPCI/PXI hardware device, the DDC LabVIEW package is a good choice for any avionics testing or development task. The DDC package also supports LabVIEW Real-Time (RT), which extends the LabVIEW framework to deliver deterministic, hard real-time performance by executing all time-sensitive application code on an embedded target running the IntervalZero (Phar Lap) ETS real-time operating system.

With the advent of PCI Express (PCI-E) as the replacement for the PCI bus in desktop computing, CompactPCI needed to evolve accordingly. CompactPCI Express was released by PICMG in 2005, keeping the Eurocard form factor, but replacing the parallel PCI Bus with serial PCI-E links. Due to the wide usage of CompactPCI systems and peripherals in the field, PICMG defined the CompactPCI Express backplane and connectors not only to support new cPCI Express cards, but also support existing cPCI cards. A hybrid peripheral slot can support either a Type 2 cPCI Express board or a 32-bit cPCI board, thereby enabling any cPCI designer to have a cost-effective evolutionary path; cPCI cards can be eventually replaced with cPCI Express cards without changing the backplane or cabling. ■

Product News

■ Curtiss-Wright adds network fabric analysis tool to debug suite

Curtiss-Wright adds the Network Fabric Analysis (NFAT) tool to its Continuum Insights 4.1 suite of GUI-based system monitoring, event analysis, and system management and multiprocessor debug software tools. The NFAT directly addresses the needs of Serial RapidIO system architecture designers.

News ID 10777

■ Kontron: COTS backplane offers 32 PCIe lanes and three PCI slots

The new Kontron 4U backplane xPB-13E9P3 for PICMG 1.3-based system designs boasts comprehensive PCI and PCI Express Gen 2 support for full-height 4U systems. With double the PCIe lanes of any previous solution, 32 in total, the PICMG 1.3-compliant backplane tackles bandwidth-intensive applications with its cost-effective and densely-packed design for use with standard PCIe and PCI extension cards.

News ID 10795

■ MEN: 3U CompactPCI Ethernet diagnosis buffer

Diagnosis buffers are used for avoiding errors and discrepancies in the system in nearly all demanding applications. MEN Mikro Elektronik now enters the market with its first 3U CompactPCI Ethernet diagnosis buffer. The F218 is a slave CPU board in 3U CompactPCI format and was developed for use as an Ethernet diagnosis buffer.

News ID 10866

■ ADLINK: PICMG 1.3 SHB supports Core i7/i5/i3 processors

ADLINK presents the NuPRO-E330, the latest PICMG 1.3 full-sized System Host Board (SHB) in its product lineup. The NuPRO-E330 supports next generation Intel Core i7/i5/i3 processors at clocks speeds up to 3.33 GHz and dual-channel DDR3 1066/1333 MHz memory up to a maximum of 8GB in two DIMM slots.

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