

# Exceeds PCI at 1.5Gbits/sec

By Craig Conway



MXI-3, a new PCI-based technology from National Instruments, allows the bridging of physically separate PCI buses via a 1.5 Gbits/sec serial link. By combining a unique serial protocol and industry standard PCI-PCI bridge interface, the MXI-3 link is able to connect separate PCI buses in a manner that is transparent to device drivers and other software. A system designer may now develop PCI- and PXI/CompactPCI-based instrumentation and control systems where the CPU is physically separated from the peripherals it controls, whether these peripherals are instrumentation and control devices, or more traditional I/O such as SCSI cards. Both copper and fiber optic versions of MXI-3 are available, allowing distances of up to 10 m and 200 m, respectively. Because the PCI interface presented by the MXI-3 link is that of a standard PCI-PCI bridge, the extension of PCI transactions across the serial link occurs transparently to device drivers and applications.

### Why MXI-3?

Figure 1 shows typical MXI-3 applications. The PCI interface of the MXI-3 link is based on the PCI-PCI bridge standard. A PCI-PCI bridge is simply a device that allows transparent expansion of one PCI bus to another. PCI-PCI bridges are used in many desktop PCs and workstations as expansion circuitry allowing additional PCI slots beyond the loading limits of a single PCI bus. These limits usually accommodate two PCI loads for the host PC's chipset and four PCI expansion slots. Figure 2 shows a typical PC/Workstation with a PCI-PCI bridge used for expansion.



Figure 1

Often in measurement and automation systems, the four standard PCI expansion slots

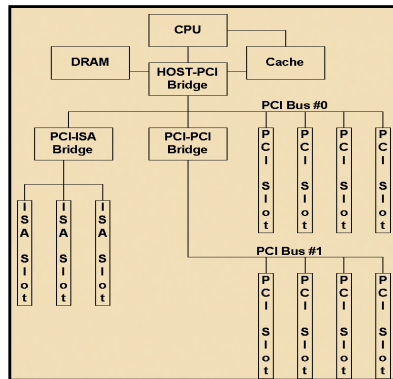


Figure 2

are not sufficient. First, there may simply be a need for more slots. Second, even in a workstation with an ample number of slots, the expanded capability may not suffice because the computer can not be placed close to the device being measured or automated. Finally, the restriction to the PCI form factor may be inadequate for the needs of the system. MXI-3 addresses all of these issues by providing the ability to transparently increase the total number of PCI based I/O modules, by separating part of the measurement and automation system from the host PC, and by combining PCI and CompactPCI devices in the same system. Multiple MXI-3 links may be used to connect the host PC or CompactPCI chassis to additional CompactPCI buses (up to the limit of 255 buses imposed by the PCI specification) in a wide array of configurations, including daisy chained and star connections.

MXI-3 is not specific to any particular processor technology. Using MXI-3, you can control a PXI/CompactPCI system using any PCI-based system, whether the

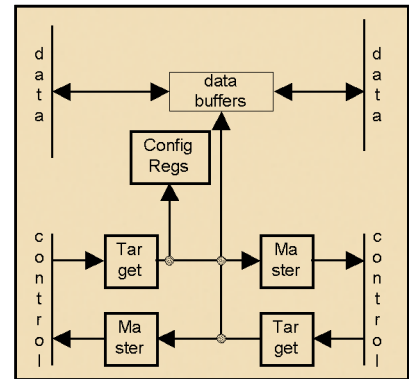


Figure 3

CPU is Pentium II/III, UltraSPARC, Alpha, PA-RISC, or PowerPC, including Macintosh, as long as the PCI devices have driver software that supports those processor platforms and the associated systems support standard PCI bridging.

### Theory of Operation

At the conceptual level, a MXI-3 link is nothing more than an off-the-shelf PCI-PCI bridge cut in two, with a high speed cable connecting the two halves. Transfers between the two PCI buses occur according to the windowing rules provided in the PCI to PCI Bridge Architecture Specification. Figure 3 shows a typical PCI-PCI bridge.

Figure 4 provides a block diagram describing the MXI-3 system architecture. A typical system consists of a primary and a secondary MXI-3 plug-in card and a copper or fiber optic cable connecting the two cards. A primary MXI-3 card corresponds to the primary PCI interface of a monolithic PCI-PCI bridge. It acts as a PCI initiator and target, but does not provide any

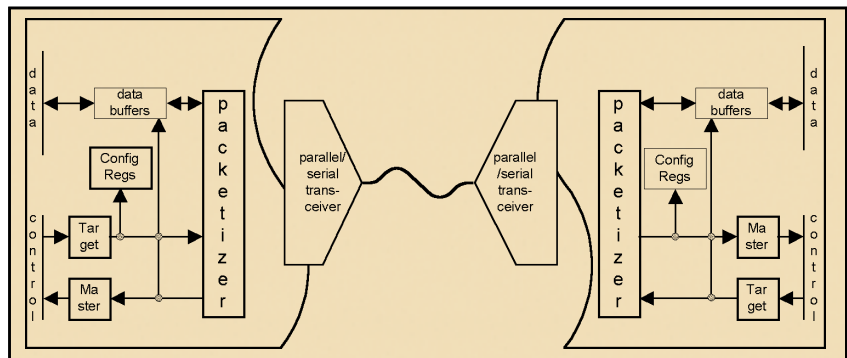


Figure 4

additional PCI functions. A secondary MXI-3 card provides clock distribution and arbitration for its PCI bus in addition to normal initiator and target activity. By plugging a PCI MXI-3 card into a desktop PC and a PXI MXI-3 card into slot 1 of a PXI/CompactPCI chassis and connecting the two cards with a copper or fiber optic cable, you can transparently link the PXI/CompactPCI chassis to the PC. The application and driver software will run unmodified on that PC as if the PC were embedded in slot 1 of the PXI/CompactPCI chassis. By plugging a PXI MXI-3 card into any of slots 2-8 of a PXI/CompactPCI chassis and a PXI MXI-3 card into slot 1 of an additional PXI/CompactPCI chassis and connecting the cards with a cable, one PXI/CompactPCI chassis can be expanded to two. The PXI MXI-3 cards detect the slot they reside in and automatically configure themselves as primary or secondary.

### System Operation

Assume a PC is connected to a PXI/CompactPCI chassis via the MXI-3 link. At power up, the PC's system BIOS scans its local PCI bus for devices. When it finds

the PCI interface of the PCI MXI-3 card, it opens memory windows in the card and performs PCI transactions searching for PCI devices through those windows. These transactions are converted into a high-speed serial bit stream and are sent to the PXI MXI-3 card that converts the bit stream back into PCI cycles. The MXI-3 protocol is a highly efficient method of transmitting information, created specifically to effectively manage PCI traffic. In addition to the serial protocol, the MXI-3 devices have a number of other performance enhancing features, including write posting and read prefetching. It complies with the PCI to PCI Bridge Architecture Specification v1.0 and the PCI Specification v2.1.

### Performance

Since MXI-3 is based on the PCI-PCI bridge architecture, its theoretical maximum performance is 132 Mbytes/sec. As with single-chip versions of PCI-PCI bridges, MXI-3 links are characterized by peak transfer rates somewhat lower than the theoretical maximum. Sustained transfer rates for MXI-3 links have been recorded at over 80 Mbytes/sec. The per-

formance is heavily dependent on the host processor and the I/O card with which it is communicating.

### MXI-3 Adapters

National Instruments offers several kits that use MXI-3 technology. A desktop PC-to-CompactPCI kit allows any PCI-based desktop computer/workstation to control a PXI/CompactPCI chassis. CompactPCI boards and varying cable lengths are available to configure multiple PXI and CompactPCI systems in either a daisy chain or a star configuration.

For more information on MXI-3 including application descriptions, data sheets, and frequently asked questions please refer to the MXI web page or contact:

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