

Benefits of the PCI Bus for Data Acquisition and Imaging

Data Translation manufactures data acquisition and imaging products for use on the high-performance PCI bus. This includes the DT3010 Series, DT3000 Series (PCI-EZ), and DT300 Series for data acquisition, and the MACH Series (DT3152, DT3152-LS, DT3153, DT3154, DT3155, and DT3157) for imaging. By taking advantage of the PCI bus, these plug-in boards offer convenient and affordable high-performance solutions for demanding data acquisition and imaging applications.

What Is the PCI Bus?

The PCI (Peripheral Component Interconnect) bus is an integral part of today's Pentium high-performance personal computer systems. Conceived and designed as a way to give peripheral components high-bandwidth access to the host processor in a PC, the PCI bus is a board-level expansion standard with important benefits to anyone whose work involves PC-based data acquisition or image processing. In replacing the aging 3 to 5 MB/s ISA (Industry Standard Architecture) expansion bus, the PCI bus breaks open the bandwidth bottleneck by providing a 132 MB/s (theoretical), 95 MB (typical) burst-rate highway. In addition to its high bandwidth, the PCI bus features master/slave operation to reduce latency and offload the host CPU. Other advantages include Plug 'N Play autoconfiguration to simplify installation; processor and platform independence, which lets designers easily develop PCI peripherals to run on other platforms than the Pentium PC; and a specified migration path to 3.3 V, which simplifies the design of portable systems.

Bandwidth Breakthrough for Fast Data Rates

For all its longevity, the 16-bit, 8 MHz ISA peripheral expansion bus developed for the PC AT in the 1980's has long needed a higher-performance successor to meet the increasingly demanding data rates of multimedia, network, disk drive and other peripherals.

By transferring 32-bit words at up to 33 MHz clock rate, the PCI bus meets these demands by achieving a maximum data-burst rate of 132 MB/s and continuous data transfers of 100 MB/s. Moreover, PCI has the potential to transfer even wider, 64-bit, data words and at a faster, 66 MHz, clock rate.

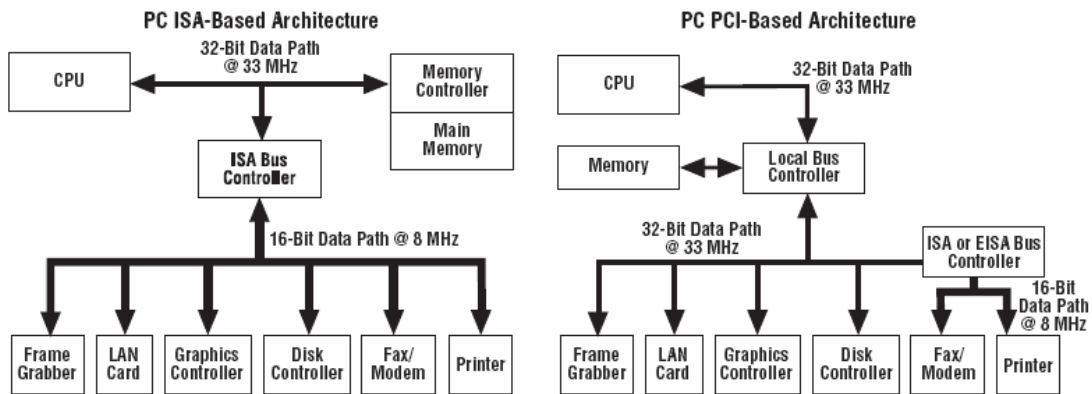
PCI Bandwidth Comparison

Bus or Subsystem	Transfer Rate (MB/s)
ISA	3 to 5
EISA	33
PCI	132
Full Motion Video2 to 11 per window
SVGA	30 to 40
Hard Disk	4 to 20 using SCSI
10/100 Mbps Ethernet.	2/20

Bus Mastering for Low Latency

Besides a faster data rate, the PCI specification also allows for both master and slave devices to exist on the bus. A master peripheral can initiate large, high-speed data transfers to memory across the bus without help from the host processors. In contrast, peripheral boards that operate as bus slaves are controlled by the host processor, which directs the board's bus read and write operations.

While slaves are adequate for slow data acquisition sampling rates, data acquisition applications above 1 MSamples/s and imaging applications that require 10 to 40 Mbyte/s data transfer rates often need the guaranteed response time and added flexibility of a bus master. Bus masters, such as the DT3010 Series, the DT300 Series, and MACH Series boards, have the capacity to "own" the PCI bus; that is, they can be the sole resource to execute bus cycles. What's more, the low 3 μ s access latency of the PCI bus lets bus-master peripherals take control of the PCI bus in a tenth of the time of other buses.



ISA-based frame grabbers can transfer data no faster than the relatively slow ISA Bus. PCI-based designs (right) send image data across a high-speed 33 MHz PCI Bus, for real-time transfer to the CPU or system memory.

Processor Independence

The PCI bus is processor independent it not only operates independently of the CPU but also works with any number of microprocessors. Peripherals built around the PCI bus may work on any PCI machine, be it one with a Pentium, Alpha, or PowerPC™ processor. Data Translation's PCI-based data acquisition and imaging boards have been developed to support Intel X86 processors running under Microsoft® Windows® 3.1, Windows 95, and Windows NT.

ISA Bus Performance Degrading

In computers that have both PCI and ISA buses, the ISA bus operates as a peripheral on the PCI bus. The performance of the ISA bus in this configuration is even lower than in older systems that do not have PCI buses. This is because in dual bus platforms, the ISA bus is formed by a PCI-to-ISA bridge, an arrangement that gives first priority to peripherals on the PCI bus. One consequence of this arrangement is that DMA (direct memory access) latency increases on the ISA bus. In contrast, PCI has direct access to memory, achieving fast data transfer operations without the need to set up DMA channels.



Benefits of PCI for Data Acquisition Applications



For data acquisition, the high-bandwidth of the PCI bus allows simultaneous, real-time gathering of gap-free analog and digital input data, along with outputs for analog stimuli and digital control.

Data acquisition boards built for the PCI bus can feed acquired data directly to the PC's memory, minimizing the need for onboard memory. Unlike ISA boards, which run the risk of overflowing data because they need a large onboard memory buffer, PCI data acquisition boards do not leave gaps in the acquired data. In other words, PCI boards do not lose data like ISA boards can if the bus does not respond fast enough to the board's request to transfer data. High bandwidth also ensures gap-free data transfer by allowing several subsystems to be active simultaneously rather than sequentially. For example, Data Translation's DT3010 and DT3000 Series PCI-based boards feature continuous performance, which provides gap-free simultaneous A/D, D/A, and digital I/O operation at full-rated throughput. To do this, the boards have circular buffers that store multiple values that are transferred across the PCI bus simultaneously to take advantage of the high bandwidth. The DT3010 board features an A/D throughput of 1.25 Msamples/s from one channel, up to 32 analog inputs, two analog outputs, up to 16 digital I/O lines, and four user counter/timers. The DT3003 board features an A/D throughput of 330 kHz from one channel, up to 64 analog inputs, two analog outputs, and eight digital I/O lines.

Because boards on the PCI bus can transfer without intervention from the host CPU, data can be simultaneously acquired and processed in real time. For example, as data is sampled, the host CPU can perform a mathematical operation, plugging the results into a spreadsheet for analysis. Moreover, by adding digital I/O functions, you can set up real-time collection and control experiments that would be impossible to conduct across the ISA bus. For example, a data acquisition system running on the ISA bus would run out of bandwidth carrying just two analog outputs and one analog input, each

running at 200 kSamples/s. Plus, due to the Plug 'N Play feature of the PCI bus, system resources are all configured automatically. No jumpers or DIP switch settings are required.

Benefits of PCI for Imaging Applications

For image processing, PCI lets applications stream live video to a display or system memory, virtually eliminating the need for costly onboard memory. For example, a video camera that sends 30 frames/s produces data streams of 10 to 40 MB/s, far outpacing ISA's capacity of 3 to 5 MB/s of continuous data. The effect in ISA-based imaging boards is to create a data bottleneck, in which data is generated faster than it can be transferred. To store the overflow takes costly, bulky onboard memory. In contrast, PCI-based imaging boards, like Data Translation's MACH Series frame grabbers, can transfer the video directly into the host system's main memory. Also, since they are PCI masters, the MACH Series imaging boards leave the host CPU free to perform image processing operations and calculations.

Real-Time Display, Non-Destructive Overlays

MACH Series frame grabbers employ Microsoft's DirectDraw (DDI) standard, allowing you to display real-time, live video with non-destructive overlays without adding costly display hardware (i.e. VGA circuitry) to the frame grabber. This approach offers many advantages over traditional frame grabber display and overlay methods, including: **Minimal CPU Bandwidth:** The DirectDraw display technique requires minimal CPU bandwidth, leaving the CPU free to perform image processing or other tasks. Ideal for applications where display video and processing occur simultaneously, DDI allows for stagger free images and smooth flowing, real-time video with overlays.

Upgradable Compatibility: With DDI, your MACH Series frame grabber will work with any DirectDraw-compatible graphics card. And since DirectDraw is enabled through the graphics card driver, you can upgrade an existing graphics card to DDI by simply loading a new driver.

Flexible Graphics Card Selection:

Because the graphics card is not built onto the frame grabber, you are not “locked in” to the performance of the frame grabber’s display circuitry.

This allows you to choose the frame grabber that suits your needs and the graphics card that meets your performance requirements and budget. You can switch the graphics card and upgrade the display performance over time



New software allows flexible use of non-destructive overlays on live images using MACH Series boards.

by simply installing the new card and driver software — with no frame grabber or software changes needed. This approach has strong advantages over frame grabbers designed with onboard display hardware, which confine you to the limitations of the onboard display and/or limit your choices of graphics cards by the use of non-standard display methods.

Additional Features: Since DDI is the same overlay technique used by video game manufacturers, this capability gives you the ability to have non-destructive overlays of any size, shape, or color on top of live video. In addition, overlays can be translucent (semi clear), rotated, animated, or even placed over scaled images.

The Right Solution for Demanding Applications

PCI has replaced ISA as the bus of choice in new desktop and industrial PCs. With the PCI bus, high-performance, low-cost, and convenient PC-based image processing and data acquisition solutions are at hand.