



# DATA ACQUISITION CARDS

# INTRODUCTION



- Once the signal has been amplified and cleaned up, it must be fed into a computerized system for collection and analysis.
- Nowadays, most data acquisition systems use standard PC hardware, meaning that if components of the system fail, they can be easily replaced with off-the-shelf items.
- The most common format for getting an incoming signal into a computer nowadays is the use of PCI cards and other hardware.
- Though originally designed for PC, PCI (**Peripheral Component Interconnect**) cards compatible with many other systems are now available.
- These external PCI cards are a solution to a common problem that with complex data acquisition systems measuring many variables, the number of PCI inputs on a typical motherboard is too few.
- DAQ cards often contain multiple components that are able to perform signal processing before passing the signal to the software.
- In the most advanced cards, these functions are accessible via a bus by a micro-controller, though some cheaper systems used hard wired logic.
- For both types of card, proprietary device drivers are often needed.
- These signal processing controllers are increasingly able to perform quite complex processing on incoming signals, it shifts the burden of signal processing away from the CPU, which in large complex systems can become choked by an overload of data.

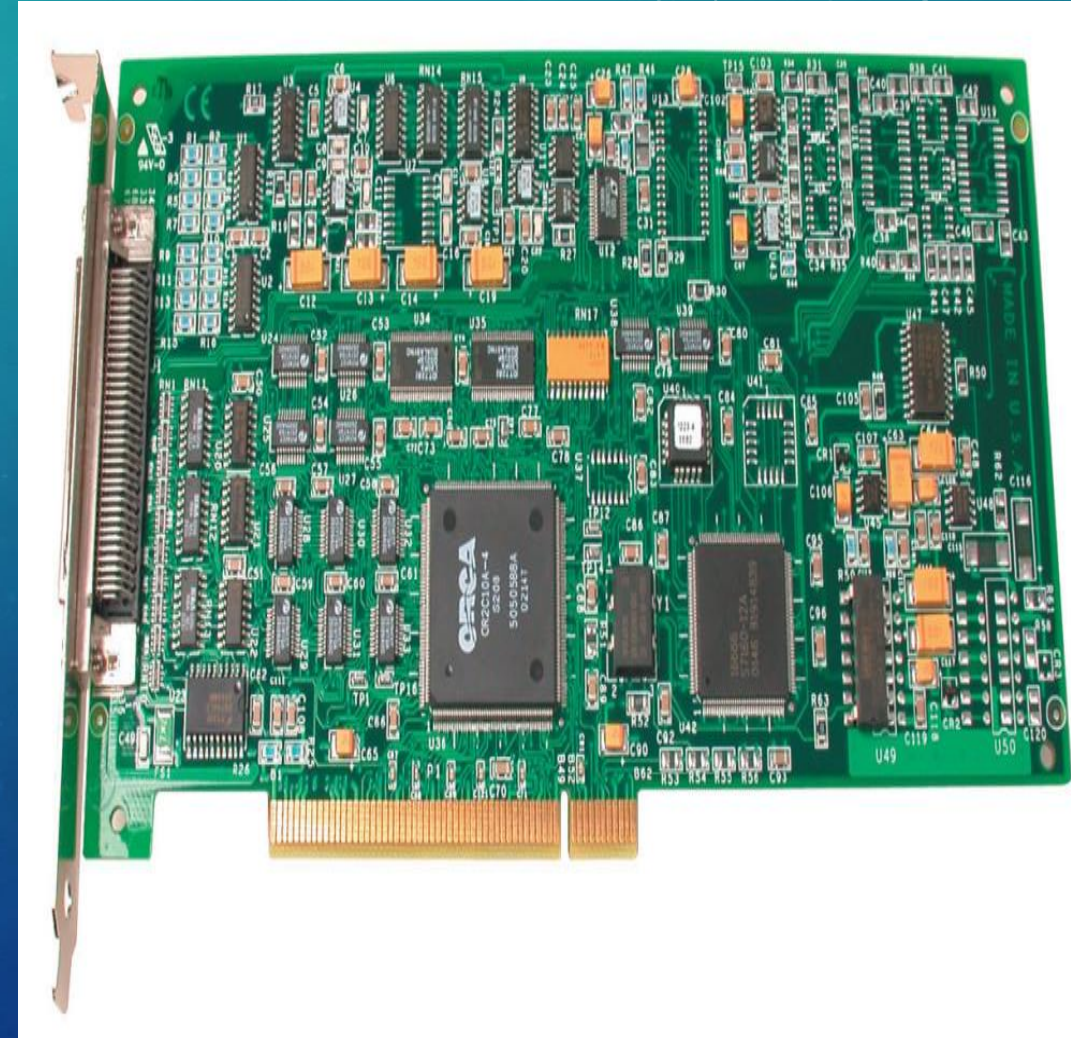
# COMMERCIAL DATA ACQUISITION CARDS

- A large number of manufacturers produce data acquisition hardware products for PCs.
- The largest market is for Microsoft Windows-based, PCI-bus and ISA-bus (Industry Standard Architecture) computers running Intel or compatible processors.
- For these machines, most data acquisition hardware products are cards that plug into a PC's expansion bus.
- Typically, the newest and fastest products are PCI based.
- Many ISA-bus products are still available, but they are not recommended for new applications.
- ISA boards come in two major versions: 8-bit cards for PC/XT class computers and 16-bit cards for AT (ISA) machines.
- Many products have additional hardware, external to the PC, which connects to the main data acquisition card.
- These add-on devices include connection boxes, signal conditioning boards, and high-power I/O interfaces, including relay boards.
- Some PC-based data acquisition systems consist of an external box connected to the PC's bus for control, usually via a special interface card.



# PLUG IN CARDS

- Many data acquisition boards for PCs have dedicated functionality, such as only analog inputs. Some may have expansion capability, such as an additional multiplexer for more analog inputs.
- Other PC-based data acquisition cards are designed to be modular.
- They consist of a basic plug-in card, the *carrier*, which accepts several modules.
- These modules offer specific functions, allowing the user to tailor the hardware to his or her particular needs (such as the number of analog inputs and outputs required).
- The module functions include analog I/O, digital I/O, and signal conditioning.
- This modular approach offers greater flexibility, at a higher price.
- It is usually justified when a highly customized system is required or configuration changes will occur often.



# CLASSIFICATION OF DATA ACQUISITION CARDS

- Data acquisition cards for PCs fall into several major functional categories, including digital I/O, analog I/O, and counter/timer.
- Some boards have most or all of these features; others have only one or a few.
- There are also specialized data acquisition cards which have features geared to a particular application, such as chromatography equipment used in analytical chemistry labs.
- Another variation on data acquisition cards is the virtual instrument.
- This type of device is a combination of hardware (a card) and software that emulates the functionality of a standard test instrument, such as an oscilloscope or function generator.
- The user interface is a graphics environment that looks like the front panel of the emulated instrument.
- By adjusting the virtual knobs or pressing virtual buttons, the user operates the virtual instrument.
- When the virtual instrument is an oscilloscope, the hardware consists of an analog input card.



# DIGITAL I/O CARDS

- Digital I/O cards have input and output lines typically operating at TTL logic levels (in the range of 0 to +5 V).
- Stand-alone digital I/O cards often contain some multiple of 8 I/O lines, with 16 or 24 being most common. These cards can be used as parallel, digital interfaces as well as dedicated controllers.
- Most digital I/O cards allow programming lines for input, output or both.
- Usually they contain interrupt-generation hardware.
- Some digital I/O cards support DMA for maximum data transfer speeds.

## Features

- 48 isolated digital input or output points
- 24 VDC, 200 mA per point
- Current sinking, NPN
- Optically-isolated digital I/O
- Isolated power from PCI bus and external 24 V<sub>DC</sub>
- LED indication for each I/O point



Figure: CompactPCI Digital I/O Card

# 8255A PROGRAMMABLE PERIPHERAL INTERFACE (PPI)

- A popular IC used for digital I/O was the Intel 8255A Programmable Peripheral Interface (PPI).
- This device had three 8-bit ports that could be programmed for one of three modes: simple, unidirectional I/O without handshaking; strobed, unidirectional I/O with handshaking; and strobed, bidirectional I/O on the same pins, with handshaking.
- The 8255A was controlled by addressing its control port and three data ports. It was so popular that the 8255 became an industry standard for digital I/O and it still remains a standard, long after Intel stopped manufacturing the chip.
- In current digital I/O cards (which do not use the 8255A itself), the IC's functionality is usually part of a highly integrated programmable logic device (PLD).

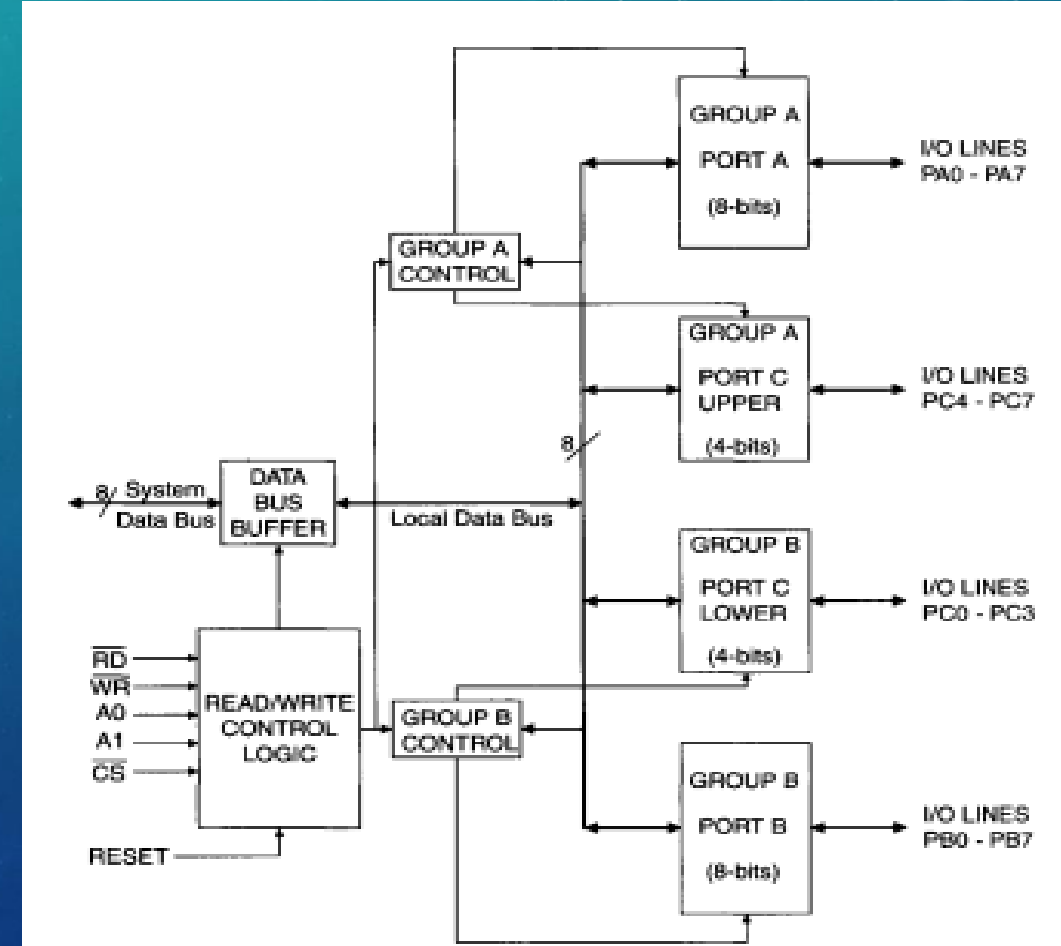


Figure: 8255A Programmable Peripheral Interface

# ANALOG I/O CARD

- They contain one or more ADCs for analog input and DACs for analog output.
- Usually, any card containing an ADC for analog input is considered a data acquisition card.
- Analog input cards typically contain one ADC IC or module along with one or more analog multiplexers.
- This enables several analog signal sources (such as conditioned sensors) to be connected to one board at the same time.
- Multiple temperature sensors may be used in monitoring different portions of a piece of equipment under test.
- Commonly, commercial ADC cards have 8-32 analog input channels.
- These channels may be differential or single-ended.
- The resolution of the ADCs and DACs used on these cards range from 8 bits to 24 bits.
- Analog I/O boards with 12-bit resolution are still the most common.
- Another important parameter is the maximum conversion rate for analog input cards.

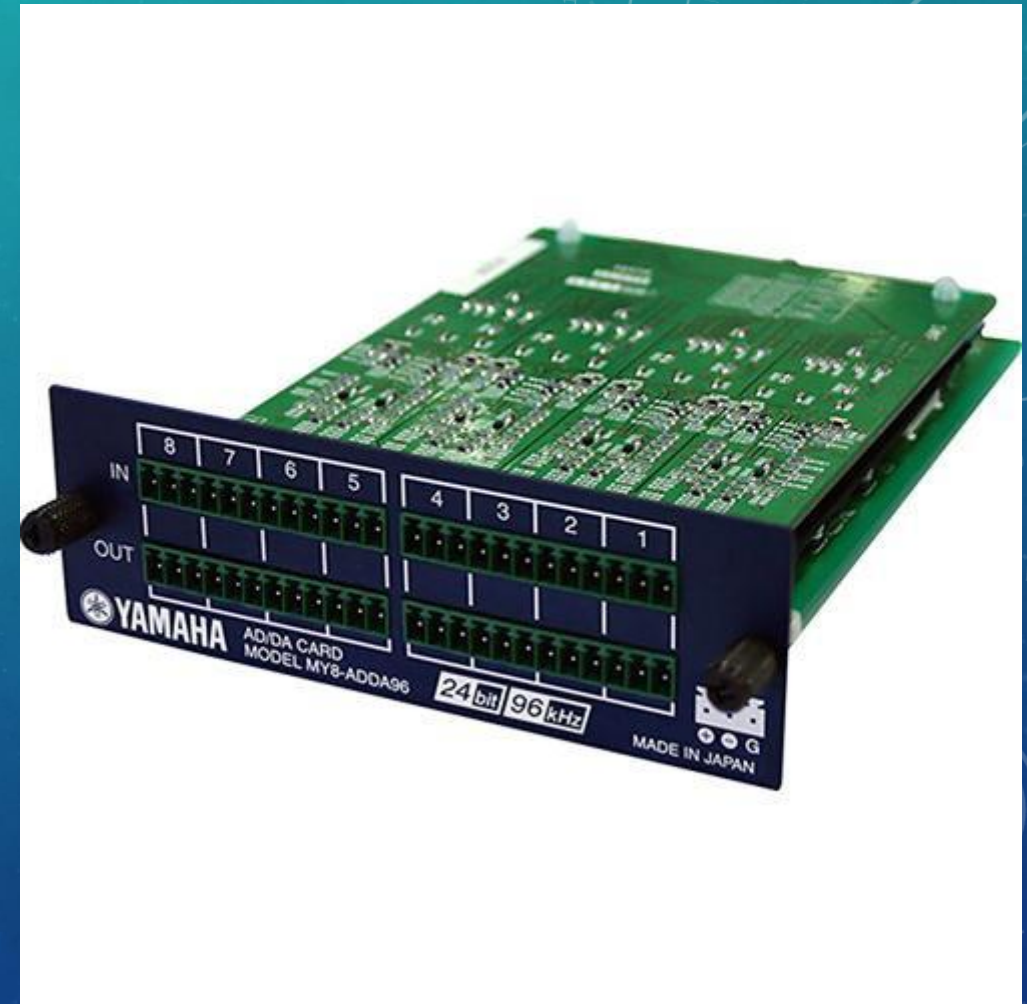


Figure: Yamaha MY8-ADDA96 - 8 Channel Analog I/O Card



# PCI ANALOG CARD

- PCI (**P**eripheral **C**omponent **I**nterconnect) analog I/O cards are potentially much faster than their ISA counterparts, because of their faster bus speed.
- Most PCI data acquisition cards are PCI version 2.1 compliant, supporting a 32-bit data bus at speeds up to 33 MHz, with a peak burst rate of 132 Mbytes/sec.
- Another important feature of many PCI data acquisition cards is bus-mastering capability.
- This allows the board to transfer data into memory as soon as it is available, without waiting for application software to respond to a poll or interrupt.
- In addition, high PCI transfer rates minimize the amount of on-board memory required by the card to buffer acquired data, before it can be transferred to the PC's main memory.



Figure:PCI ANALOG INPUT CARD

# KEITHLEY KPCI-3108 MULTIFUNCTION PCI DATA ACQUISITION CARD

- Keithley Instruments, Inc. manufactures data acquisition cards and accessories for PCI and ISA-bus computers as well as PCMCIA cards for notebook PCs, communications interface cards (serial and IEEE-488), and virtual instruments.
- Their products for PC-based data acquisition range from low-cost ISA boards, such as the DAS-8, to high performance, multifunction PCI cards, such as the KPCI-3108.
- The DAS-8 has eight single-ended analog input channels with 12-bit resolution, an input range of  $\pm 5$  V and a maximum conversion rate of 4000 samples/sec.
- It also has seven digital I/O lines (four outputs and three inputs).
- The KPCI-3108 has 16 single-ended (or 8 differential) analog input channels of 16-bit resolution with a maximum conversion rate of 100,000 samples/sec.
- The analog input range is software selectable, from  $\pm 0.0125$  V to  $\pm 10$  V, full-scale.
- It also contains two 16-bit analog output channels with a maximum conversion rate of 100,000 samples/sec and an output range up to  $\pm 10$  V.
- In addition, the KPCI-3108 has 32 digital I/O lines, three 16-bit counter/timers, 12 auxiliary digital I/O lines for timer gating or clocking, and full PCI bus-mastering capability for high-speed data transfers.



Figure: Keithley KPCI-3108 PCI data card



# KEITHLEY DAS-16 MULTIFUNCTION ISA DATA ACQUISITION CARD

- The DAS-16 is a multifunction card, with 16 single-ended (or eight differential) analog input channels of 12-bit resolution, with a maximum conversion rate of 50,000 samples/sec (the DAS-16F, with DMA support, has a maximum rate of 100,000 samples/sec).
- It has two 12-bit analog output channels, eight digital I/O lines, three timer/counter channels, and interrupt support.
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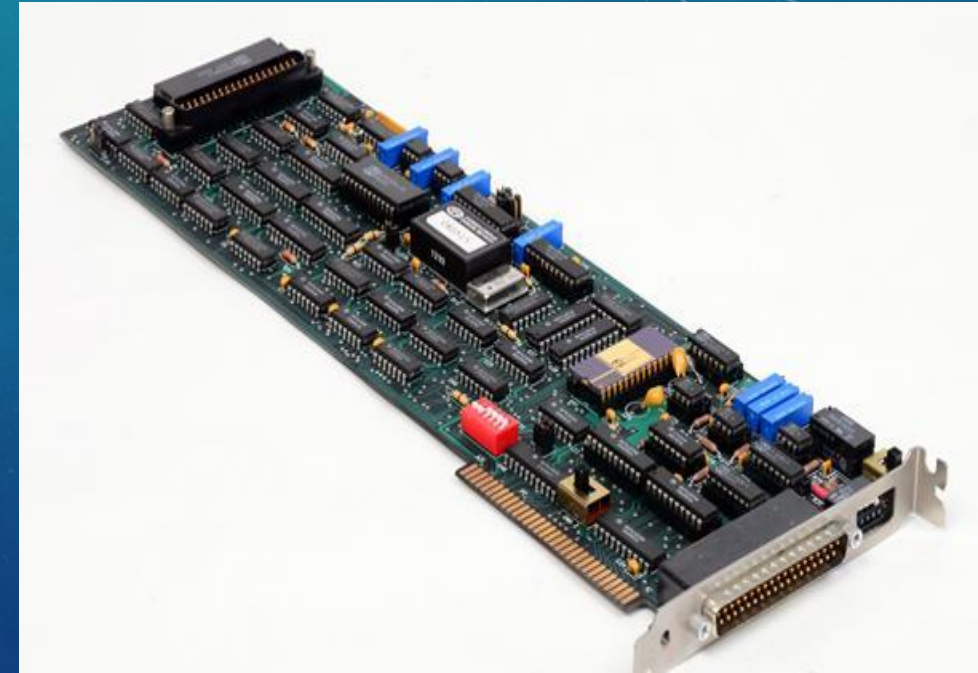


Figure: Keithley DAS-16 CARD