Electronics Instrumentation (EC0216)
Unit-4
Interfaces & Virtual Instruments

B.Tech (Electronics and Communication)
Semester-II

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Academic Year 2019-2020

General Purpose Interface Bus GPIB

- IEEE 488 is a short range digital communication, 8 -bit parallel interface bus specification developed by Hewlett- Packard as HP- IB (Hewlett- Packard Interface Bus). It subsequently became the subject of several standards, and is generically known as GPIB (General Purpose Interface Bus).

- The GPIB or General Purpose Interface Bus or IEEE 488 bus is one of the most popular and versatile interface standards available today.

- GPIB (General Purpose Interface Bus) is an interface between computers and measuring instruments. It is mainly used to connect PCs and measuring instruments.

- Today most bench electronics test equipment has either a GPIB option or are fitted with it as standard.

GPIB

GPIB Cable

GPIB Connector

IEEE 4888 (GPIB) Features

- IEEE 4888 has a 24-pin connector and is used for double headed design. Both ends of cable are used, male on one side and female on other side.

- It has 16 signal lines. 8 lines are dedicated for bi-directional communication, 5 lines are used for bus management and 3 lines are dedicated for handshakes.

- 8 data lines allow digital message (1 byte=8 bits) to be sent at a time.

- It allows 15 devices to be shared over single physical bus.

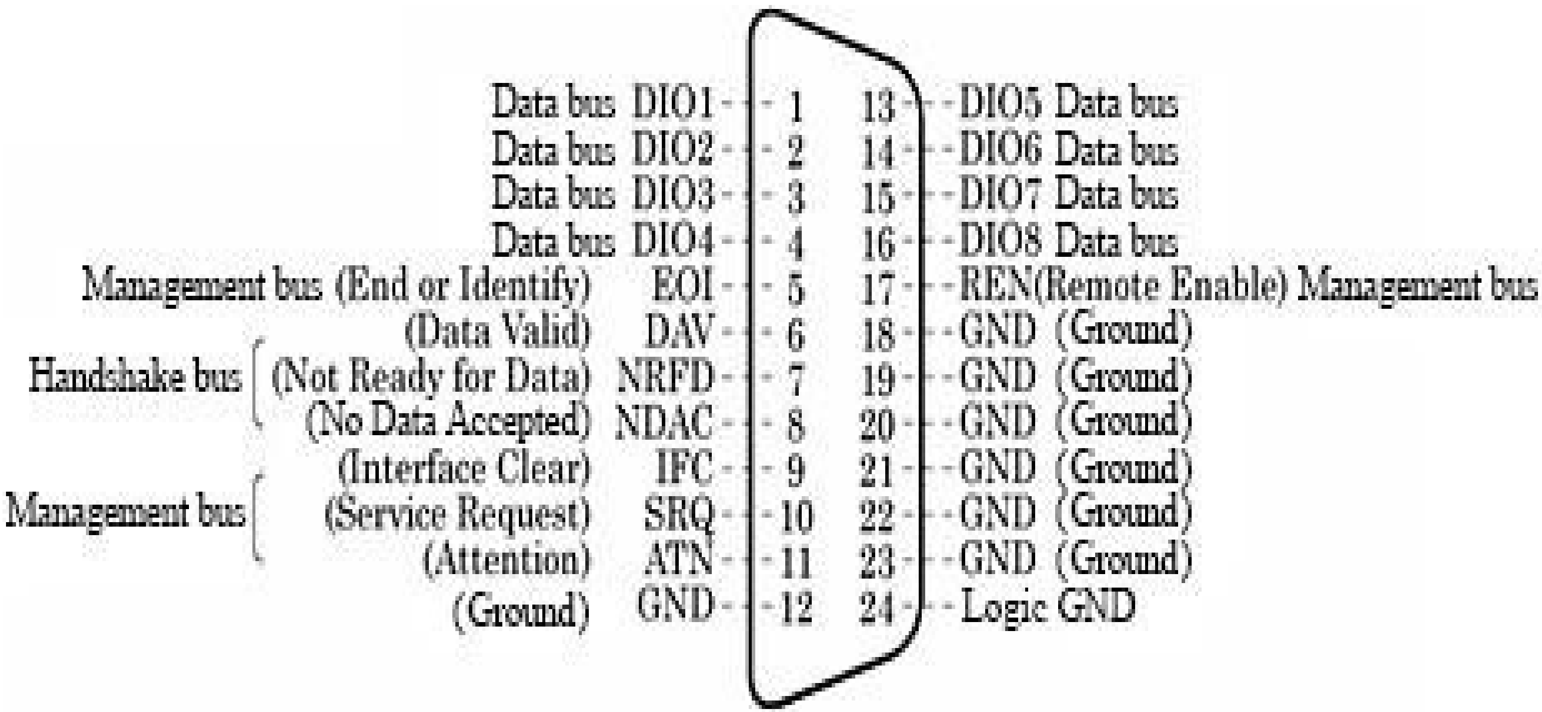
- Total bus length may be up to 20 m and distance between devices may be up to 2 m.

GPIB Features

IEEE 488 BUS / GPIB FEATURES SUMMARY

PARAMETER	DETAILS
Max length of bus	20 metres
Max individual distance between instruments	2 metres average 4 metres maximum in any instance.
Maximum number of instruments	14 plus controller, i.e. 15 instruments total with at least two-thirds of the devices powered on.
Data bus width	8 lines.
Handshake lines	3
Bus management 5 lines	
Max data rate	~ 1 Mbyte / sec (HS-488 allows up to ~8Mbyte / sec).

GPIB Controller PINOUT



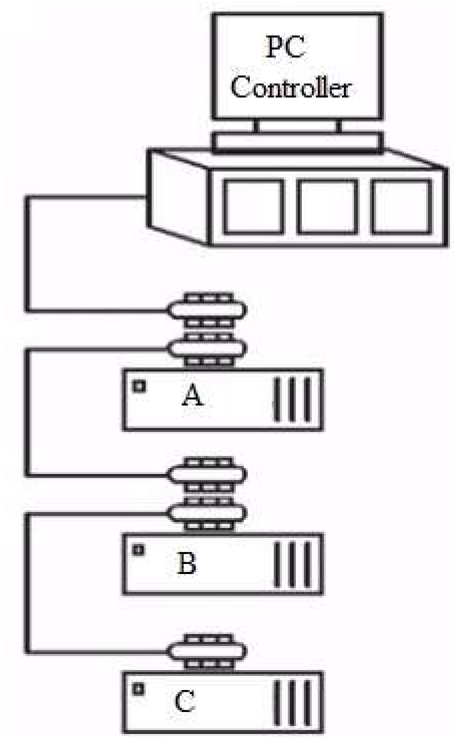
Advantages

- Simple & standard hardware interface
- Interface present on many bench instruments
- Rugged connectors & connectors used .
- Possible to connect multiple instruments to a single controller
- Handshake communication ensures highly reliable data transfer
- Devices with different communication speeds can be connected.

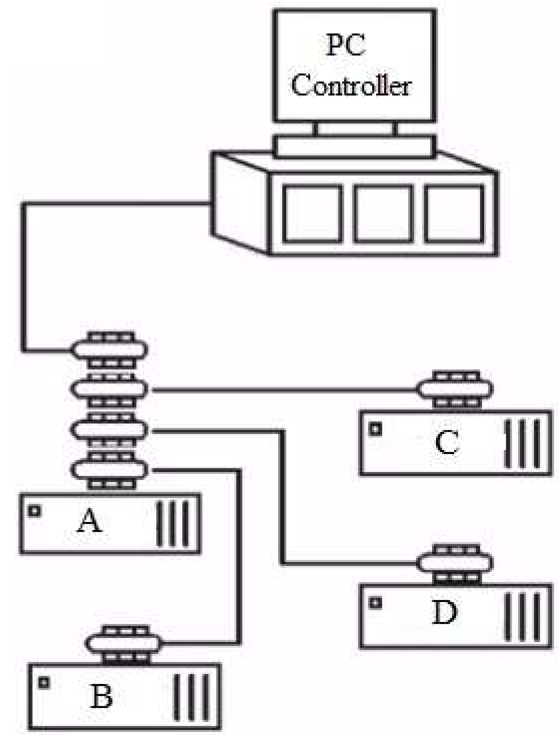
Disadvantages

- Bulky connectors
- Cable reliability poor - often as a result of the bulky cables.
- Low bandwidth - slow compared to more modern interfaces
- Basic IEEE 422 does not mandate a command language

GPIB Connection methods

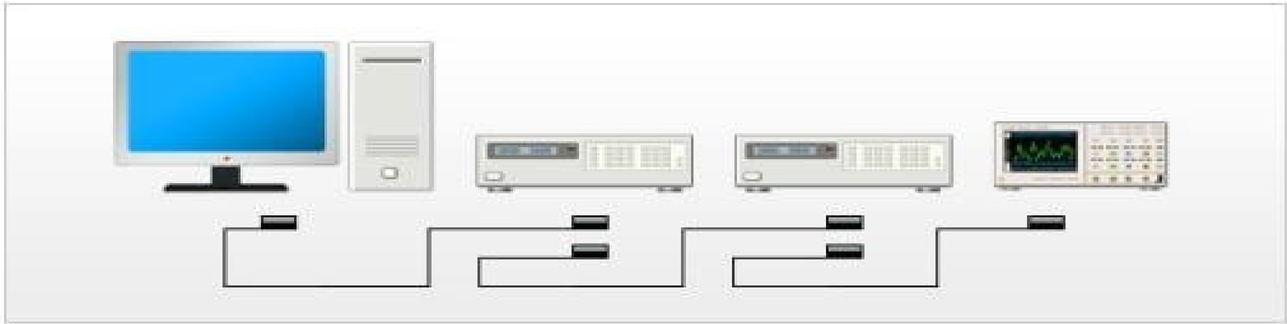


Linear Instrument Connection

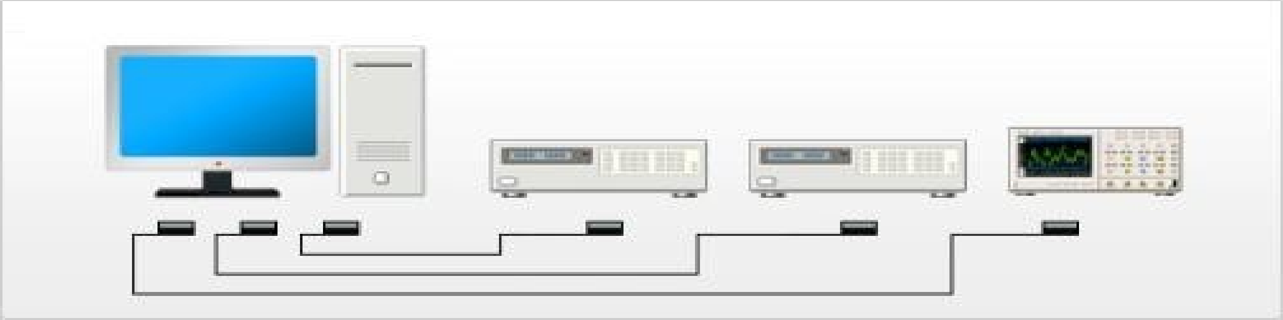


Star Instrument Connection

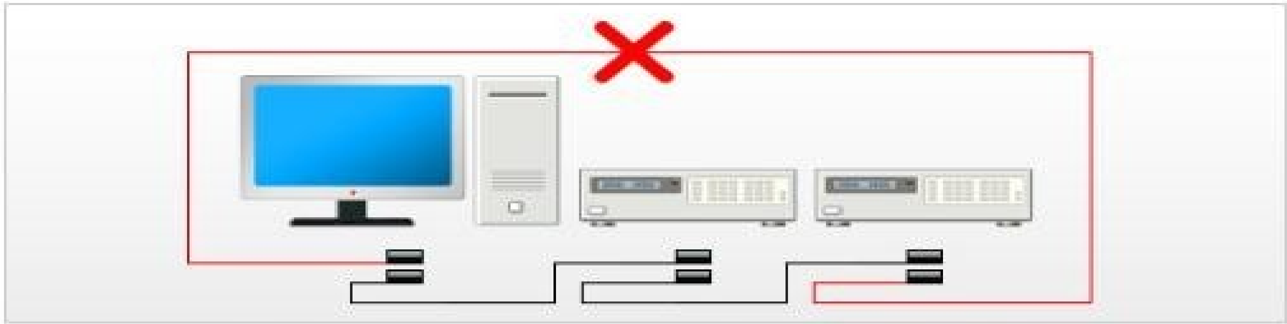
Connection methods



Daisy chain connection



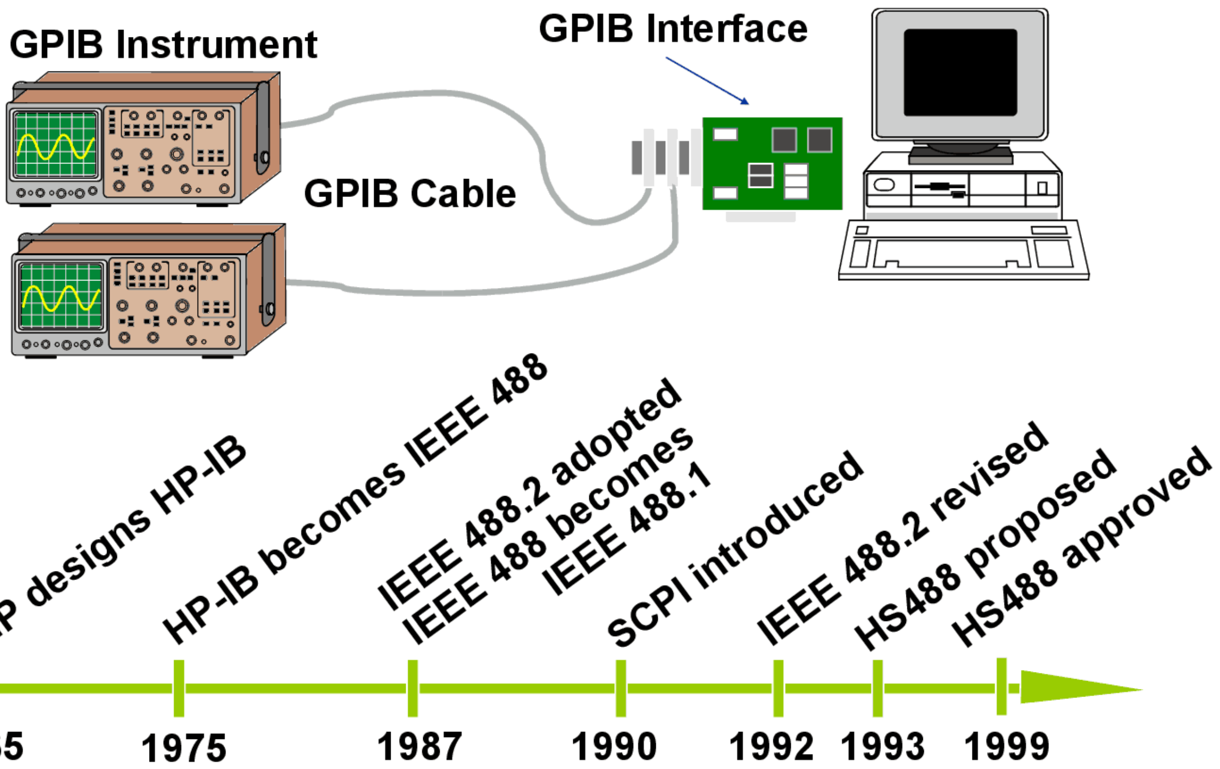
Star connection



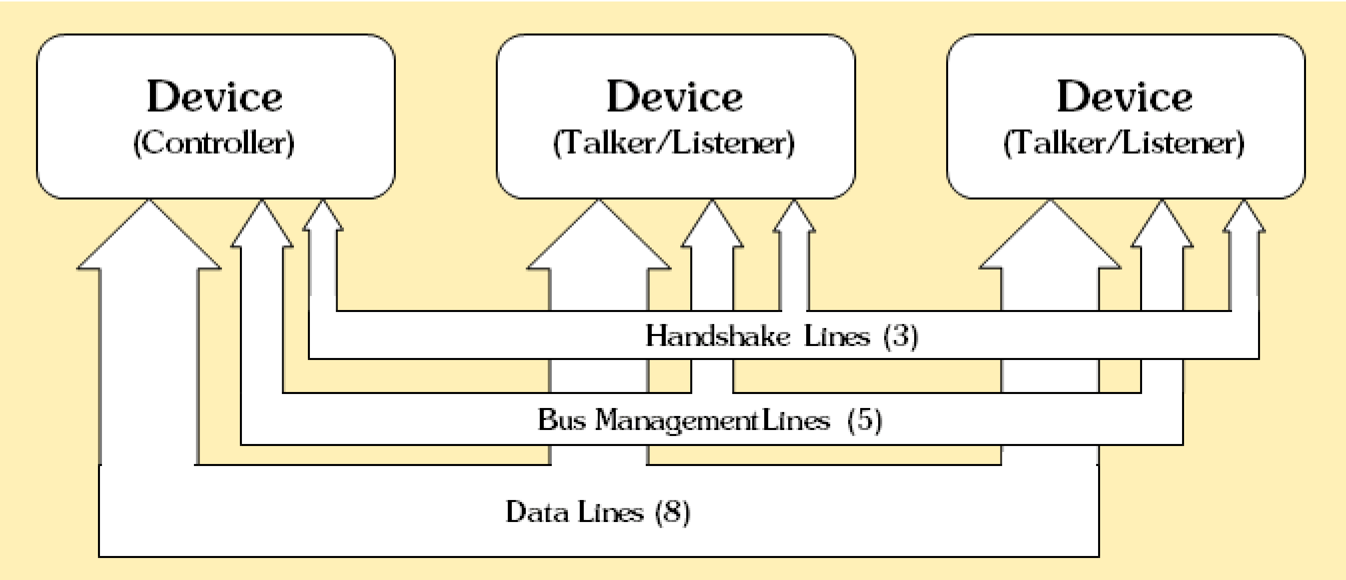
Caution: Devices must not be connected in a loop arrangement.

Typical example of GPIB communication

GPIB Communication



How does it work?



Talkers, listeners & Controllers

- Of the devices connected on a bus, devices that receive data are called "listeners," while devices that send data are called "talkers."Talkers and listeners are specified by the controller. The device that manages the whole system is called the "controller", which is normally a computer (PC).

- As the name suggests, the master is the device that has the power to make decisions regarding GPIB communication (command transmission, etc.,) while the slave must obey instructions issued by the master (command receipt, etc.) When configuring a system there must be one master and at least one slave. When controlling a measuring instrument, the PC acting as the controller is the master.

Role of Controller

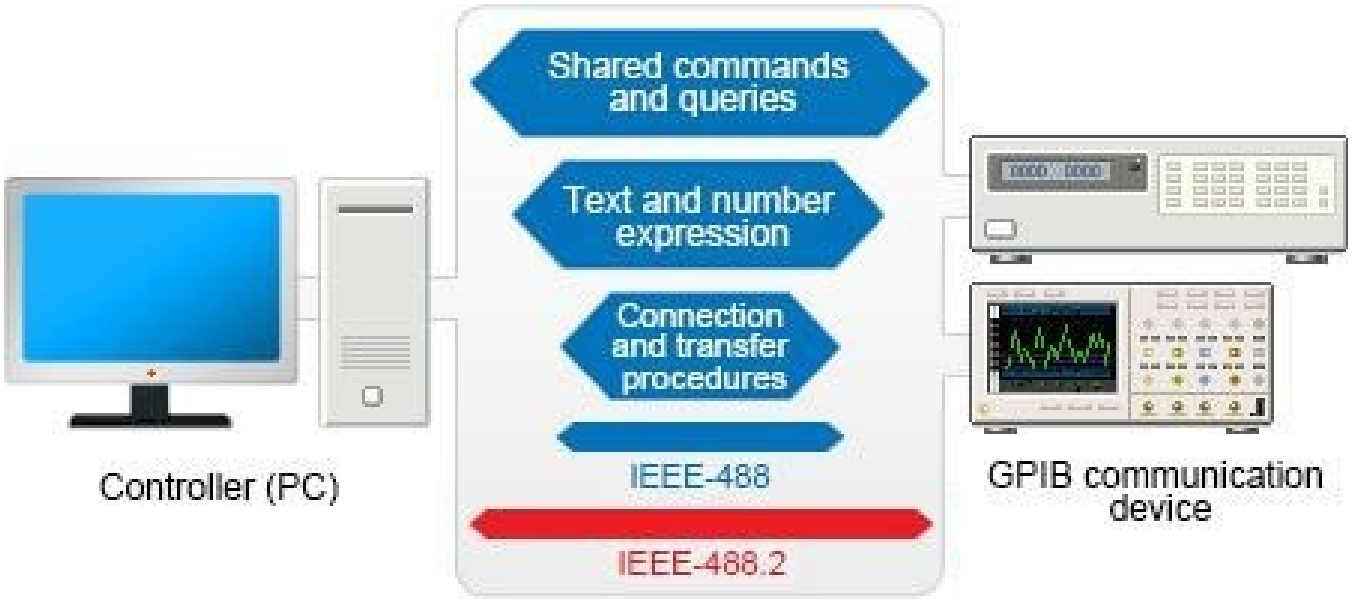
- To prevent data from colliding, the number of devices on a GPIB bus line that can send data at any point in time is restricted to one. The device that achieves this is the controller. The controller mainly performs the operations below. If these operations are expressed in a program, it is possible to build a GPIB system that has a PC as a controller.

- Specifies the talker.
- Specifies listeners with respect to the talker. (Multiple devices possible.)
- Is able to reset the system to its initial state.
- Controls each device remotely.
- Takes the role of responding to service requests from each device.
- Is able to give commands to each device.

GPIB Standards

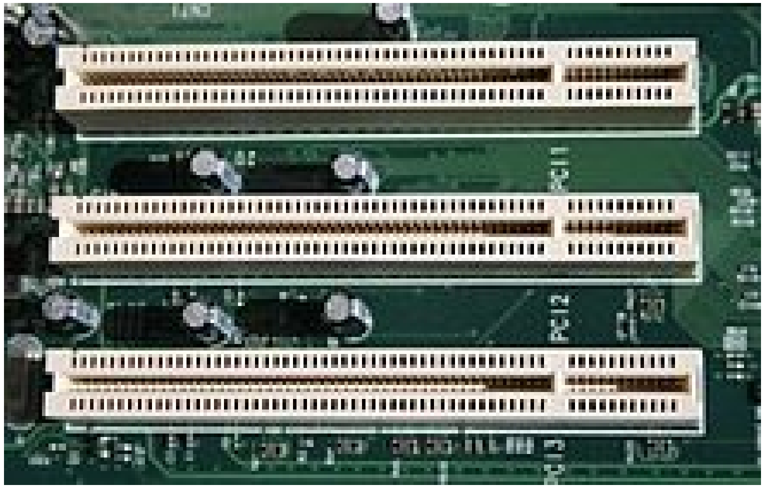
- GPIB standards include IEEE-488 and the higher level protocol IEEE-488.2, which is currently mainstream. In addition to the transfer methods specified in IEEE-488, IEEE-488.2 features syntax for text data and numeric expressions, and commands and queries that can be used by all instruments.

- IEEE-488.2-compatible instruments can communicate with other IEEE-488.2-compliant devices and with IEEE-488 devices within the scope prescribed in IEEE-488.



Peripheral Component Interconnect (PCI) Bus

- Peripheral Component Interconnect (PCI) is a local computer bus for attaching hardware devices in a computer.
- The PCI architecture, also known as "Conventional PCI" was designed by Intel and introduced in 1992.
- It is a parallel bus, synchronous to a single bus clock. Attached devices can take either the form of an integrated circuit fitted onto the motherboard or an expansion card that fits into a slot.
- Typical PCI cards used in PCs include: network cards, sound cards, modems, extra ports such as Universal Serial Bus (USB) or serial, TV tuner cards and hard disk drive host adapters.



Three 5-volt 32-bit PCI expansion slots on a motherboard

Versions of PCI

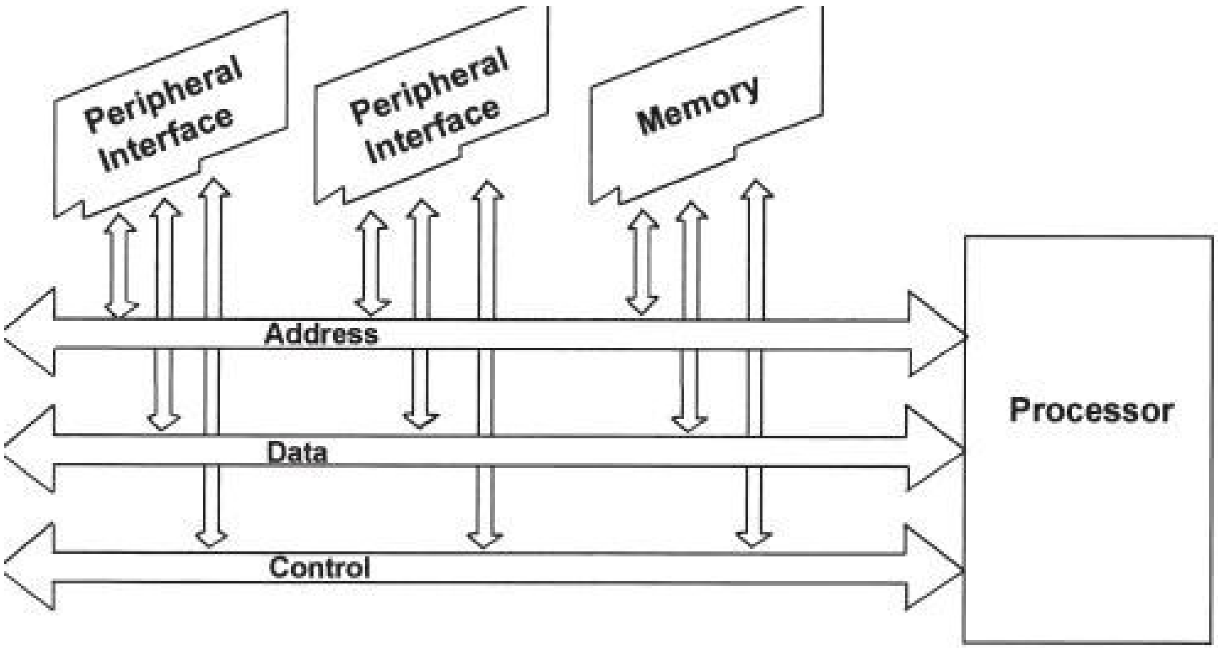
- The first version of PCI found in retail desktop computers was a 32-bit bus using a 33 MHz bus clock and 5 V signalling.
- Version 2.1 of the PCI standard introduced optional 66 MHz operation.
- A server-oriented variant of PCI, PCI Extended (PCI-X) operated at frequencies up to 133 MHz for PCI-X 1.0 and up to 533 MHz for PCI-X 2.0.
- An internal connector for laptop cards, called Mini PCI, was introduced in version 2.2 of the PCI specification.
- The PCI bus was also adopted for an external laptop connector standard – the CardBus.

Conventional PCI hardware specifications

These specifications represent the most common version of PCI used in normal PCs:

- 33.33 MHz clock with synchronous transfers
- 32-bit bus width
- Peak transfer rate of 133 MBps (133 Mega Bytes per second) for 32-bit bus width (33.33 MHz × 32 bits ÷ 8 bits/byte = 133 MB/s)
- 32- or 64-bit memory address space
- 32-bit I/O port space
- 256-byte (per device) configuration space
- 5-volt signaling

Computer Bus

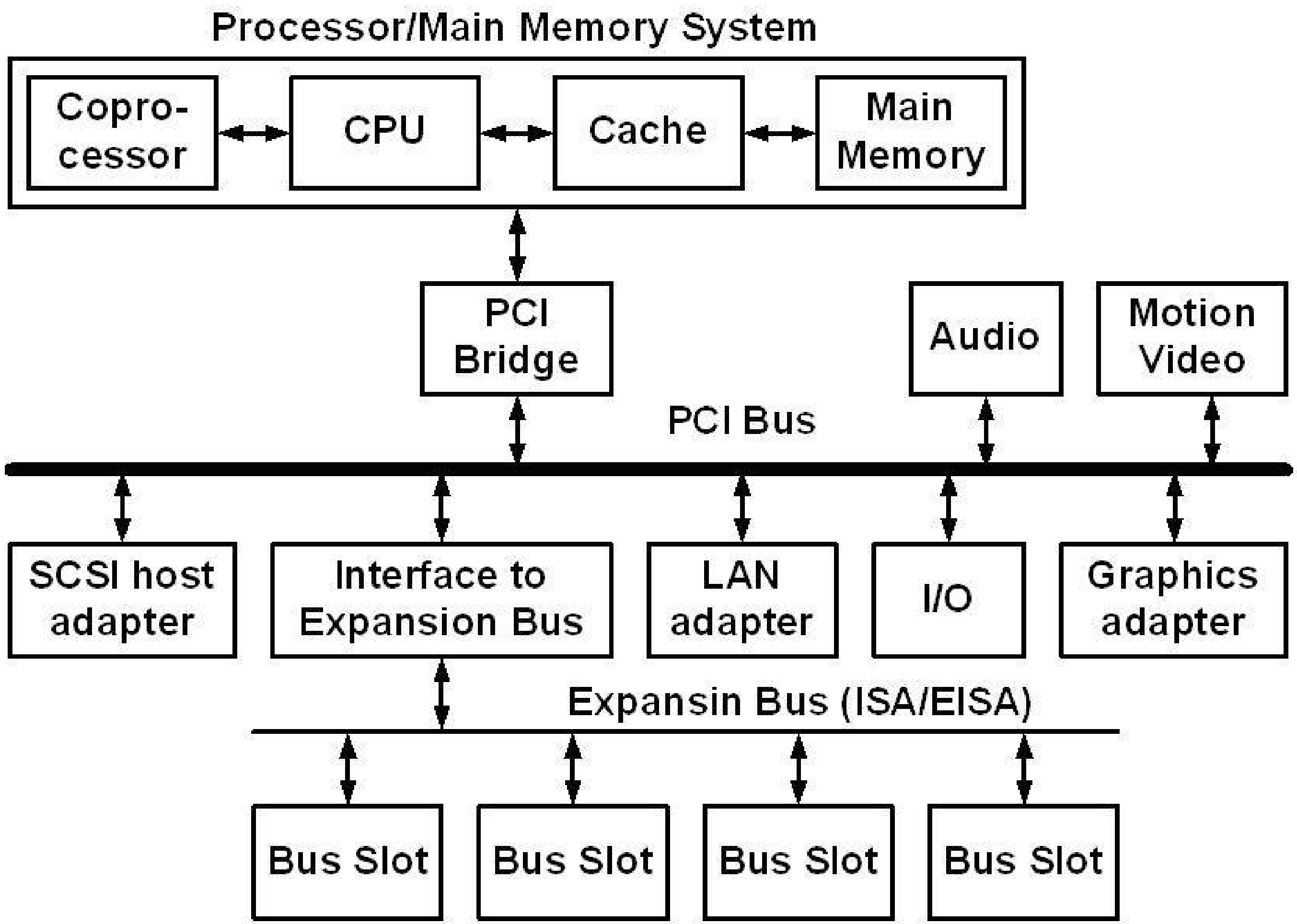


Functional diagram of a computer bus.

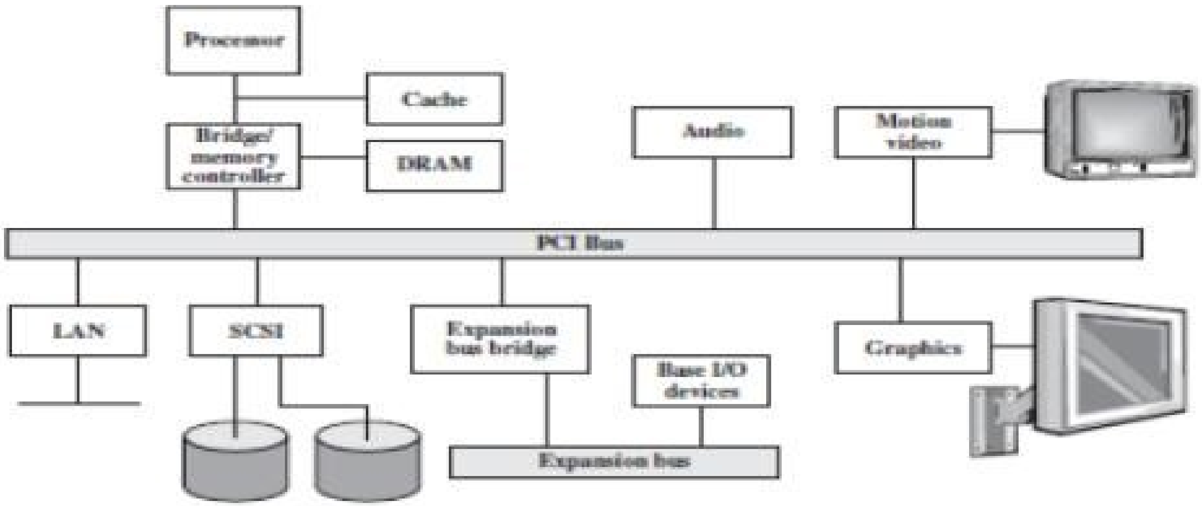
Bus Parameters.

Address width	8, 16, 32, 64
Data width	1, 8, 16, 32, 64
Transfer rate	1 MHz up to several hundred MHz
Maximum length	Several centimeters to several meters
Number of devices	A few up to many

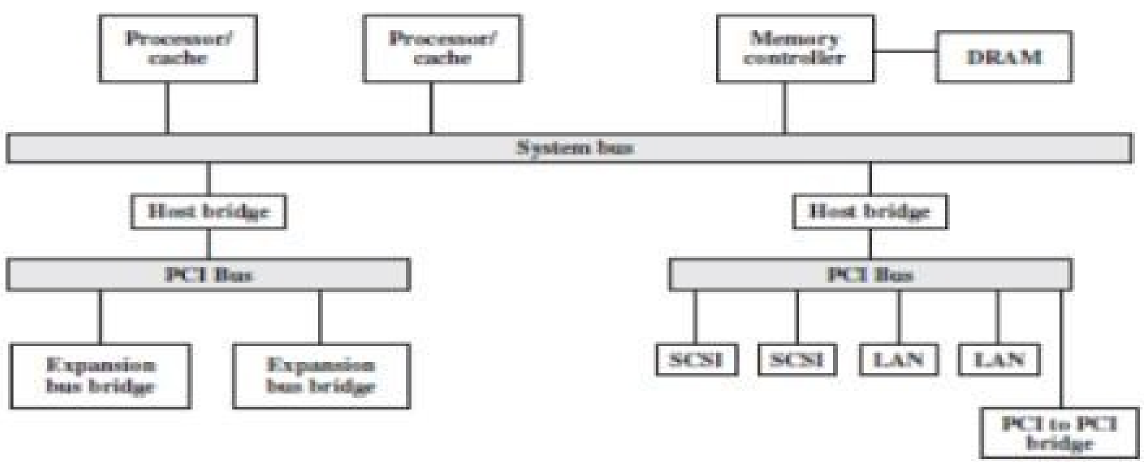
Block diagram of a PCI bus system



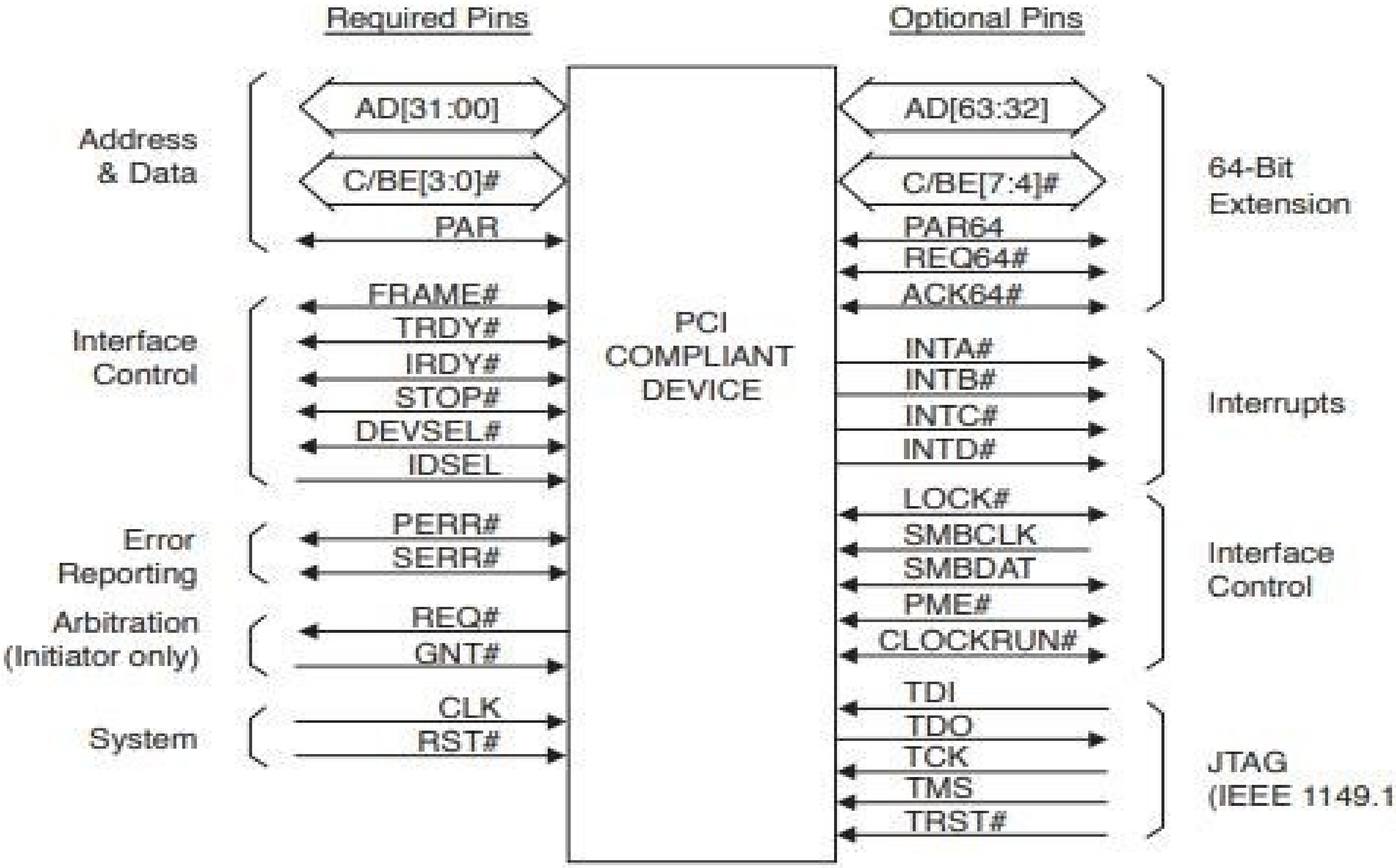
PCI Connection



(a) Typical desktop system



Signals in PCI Standard



Universal SerialBus

- USB was designed to standardize the connection of peripherals to personal computers, both to communicate with and to supply electric power.
- It has largely replaced interfaces such as serial ports and parallel ports, and has become commonplace on a wide range of devices.
- Examples of peripherals that are connected via USB include computer keyboards and mice, video cameras, printers, portable media players, disk drives, and network adapters.

USB

- Universal Serial Bus

- Universal Serial Bus (USB) is a set of interface specifications for high speed wired communication between electronics systems peripherals and devices.

- USB offers users simple connectivity. It eliminates the mix of different connectors for different devices like printers, keyboards, mice, and other peripherals.

- USB also allows hot swapping. The "hot-swapping" means that the devices can be plugged and unplugged without rebooting the computer or turning off the device.

- USB sends data in serial mode i.e. the parallel data is serialized before sends and de-serialized after receiving.

- The Universal Serial Bus gives a single, standardized, easy-to-use way to connect up to **127 devices** to a computer.
- Version

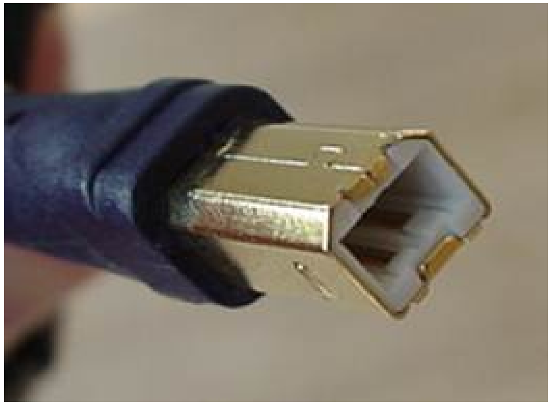
  USB 1.1

  USB 2.0

  USB 3.0

Connectors

- The USB standard uses "A" and "B" connectors to avoid confusion:
- "A" connectors head "upstream" toward the computer.
- "B" connectors head "downstream" and connect to individual devices.



- Hubs can be powered or unpowered.
- USB standard allows for devices to draw their power from their USB connection.
- A high-power device like a printer or scanner will have its own power supply, but low-power devices like mice and digital cameras get their power from the bus in order to simplify them.
- The power (up to 500 milliamps at 5 volts for USB 2.0 and 900 milliamps for USB 3.0) comes from the computer.

USB working

Enumeration

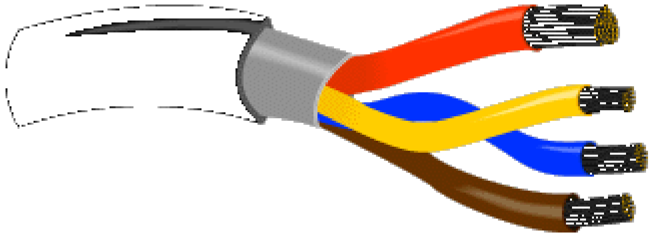
When the host powers up, it queries all of the devices connected to the bus and assigns each one an address. This process is called enumeration.

Modes Of transfer

- **Interrupt** - A device like a mouse or a keyboard, which will be sending very little data, would choose the interrupt mode.
- **Bulk** - A device like a printer, which receives data in one big packet, uses the bulk transfer mode. A block of data is sent to the printer (in 64-byte chunks) and verified to make sure it's correct.
- **Isochronous** - A streaming device (such as speaker) uses the isochronous mode. Data streams between the device and the host in real-time, and there is no error correction

USB Cable Features

- There are two wires for power +5 volts (red) and ground (brown) and a twisted pair (yellow and blue) of wires to carry the data. The cable is also shielded.



- Individual USB cables can run as long as 5 meters; with hubs, devices can be up to 30 meters away from the host.

- With USB 2.0,the bus has a maximum data rate of 480 megabits per second (10 times the speed of USB 1.0).
- A USB 2.0 cable has two wires for power (+5 volts and ground) and a twisted pair of wires to carry the data. The USB 3.0 standard adds four more wires for data transmission. While USB 2.0 can only send data in one direction at a time (downstream or upstream), USB 3.0 can transmit data in both directions simultaneously

Virtual Instruments

- Virtual instrumentation is an interdisciplinary field that merges sensing, hardware and software technologies in order to create flexible and sophisticated instruments for control and monitoring applications.

- The concept of virtual instrumentation was born in late 1970 s, when microprocessor technology enabled a machine's function to be more easily changed by changing its software.

Architecture of Virtual Instrumentation

- Sensor module
- Sensor interface
- Information systems interface
- Processing module
- Database interface
- User interface

Architecture of Virtual Instrumentation