# Chapter 4 Electronic Measurement Systems

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Second Semester,2013-2014

# Content

- 4.1 Frequency measurement;
- 4.2 Phase meters;
- 4.3 Digital voltmeters;
- 4.4 Oscilloscope;
- 4.5 Data acquisition systems;

# 4.1 Frequency measurement

- Frequency : phenomenon occurring number ,per unit of time;
- Period T: time interval between two repetitions;
- Several freq. meas. Methods:

① Resonance method;

② Freq.-to-voltage conversion;

③ Time-interval-to voltage;

④ Enumeration method;

# 4.2 Phase meters

- To meas. Phase difference between two periodic signals(in the form of AC current or AC voltage);
- Oscilloscope: roughly meas. Phase(shift);

# 4.3 Digital voltmeters

- To meas. DC voltage;
- Can meas. Slowly varying AC signals;
- Can communicate with PC, with GPIB bus;
- Programmable to realize auto ranging and polairy;
-

# 4.4 Oscilloscope

- To meas. electrical wave forms;
- Function : to make an electrical signal y(t) visible as a function of time, reproducing on the CRT screen;

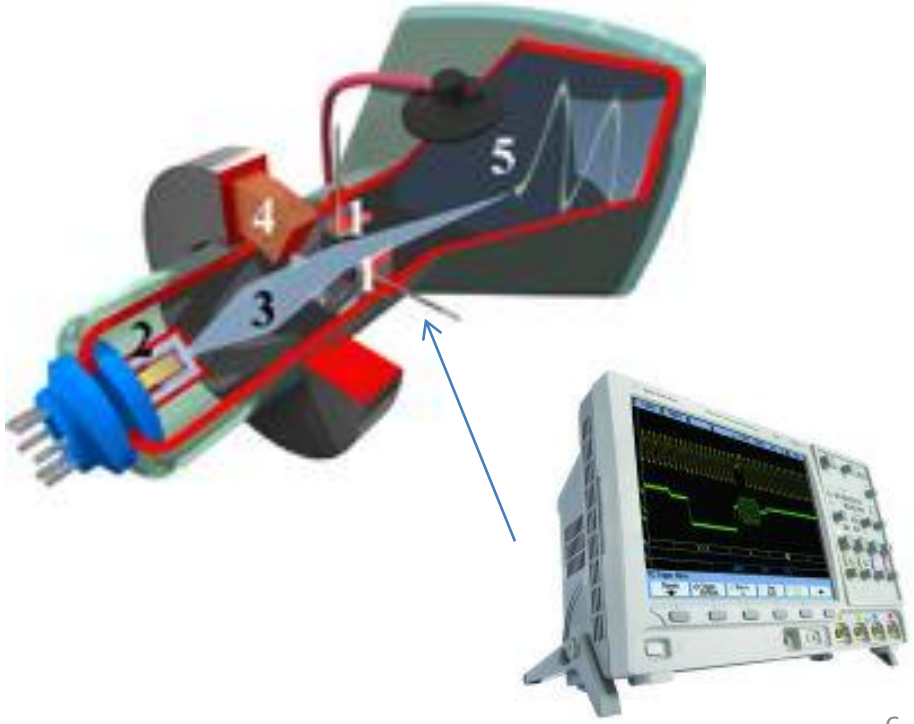



Illustration showing the interior of a cathode-ray tube for use in an oscilloscope.

1. Deflection voltage electrode;
2. Electron gun;
3. Electron beam;
4. Focusing coil;
5. Phosphor-coated inner side of the screen

# 4.5 Data acquisition systems

- DAS : a overall system required for the capture, processing, displaying and distribution of measurement information;
- Digitization: analogue signal → digital signal;
- Quantization theory;
- Sampling theory: sample and hold circuit(S/H);
- Shannon's sampling theorem;
- Reconstruction theory;
- Multiplexing : all input signals use the same processor

# Reconstruction theory

Reconstruction= inverse operation of sampling

- In time domain, sampling make an analogue signal into time-discrete data;
- Reconstruction makes time-discrete data into time continuous signal;
- In frequency domain, sampling creates higher order aliased of spectrum of input-signal;
- Reconstruction removes higher order spectra in order to recover only the base-band spectrum;

# Instrumentation-computer systems

- Computer to realize real-time or on-live processing;
- Two architectures:
- Centralized structure(Fig.4.34,p309);
- Decentralized structure(Fig. 4.35,p309);

Figure 4.34. Centralised instrumentation system.

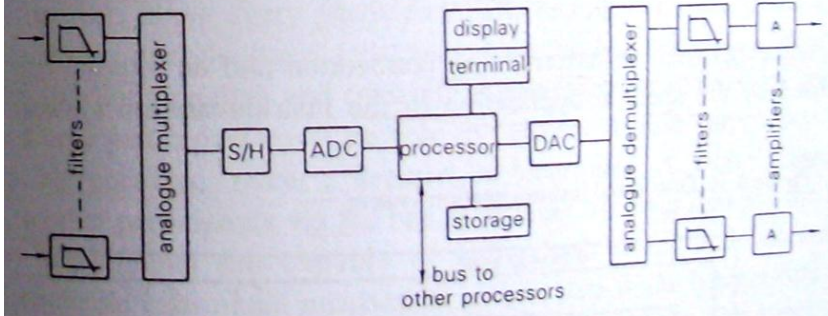
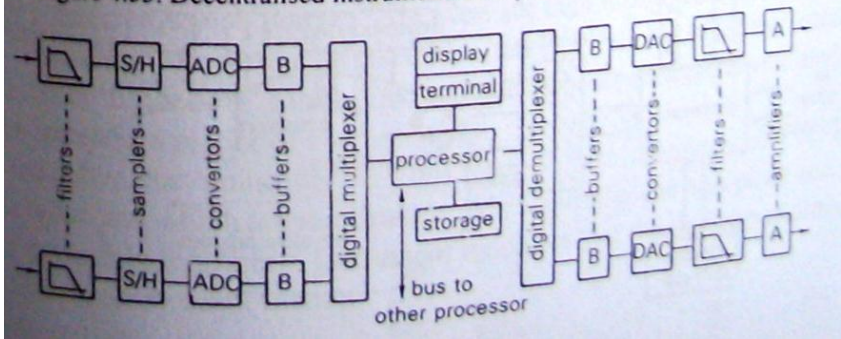


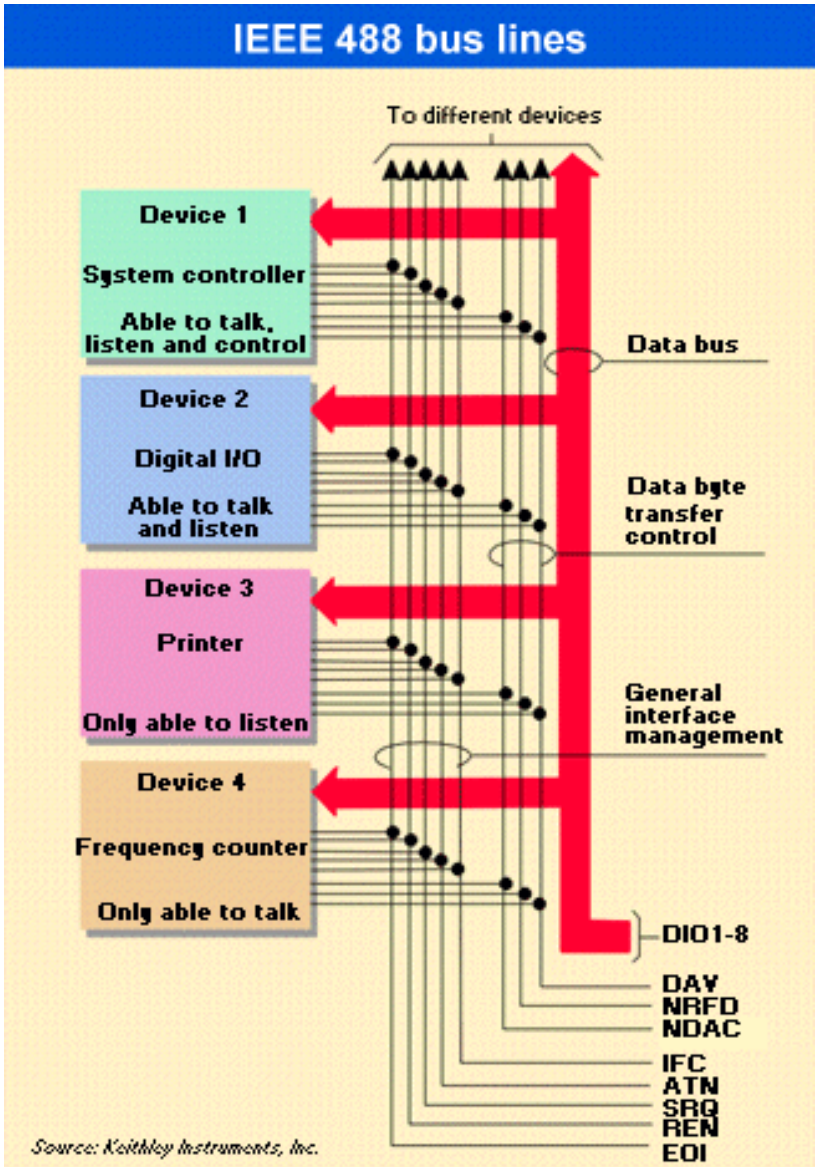

Figure 4.35. Decentralised instrumentation system.



# IEEE 488 Bus

- **IEEE:** the Institute of Electrical and Electronics Engineers
- **IEEE-488** is a short-range, digital communications bus specification that has been in use from 1978;
- IEEE-488 is also commonly known as **HP-IB** (**Hewlett-Packard Interface Bus**) and **GPIB** (**General Purpose Interface Bus**).
- IEEE-488 allows up to **15** devices to share a single eight-bit parallel electrical bus by daisy chaining connections;

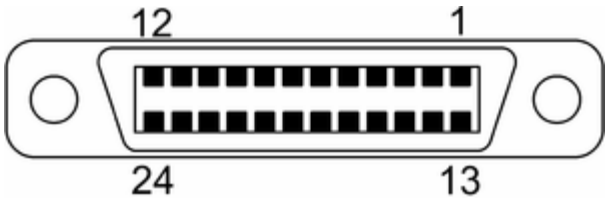
# IEEE 488 network




# IEEE-488 connector

- The IEEE-488 connector has 24 pins. The bus employs 16 signal lines — eight bi-directional used for data transfer, three for handshake, and five for bus management — plus eight ground return lines.

IEEE-488 stacking connectors




A female IEEE-488 connector

# Notes

Functions of a Participant

① Talker: to transmit data;

② Listener: to receive data;

③ Controller: to manage bus;

- Not all devices need to respond to all lines of the bus;
- TTL (Transistor-Transistor Logic)signal;
- Negative logic: true(1) by low voltage, false(0) by high voltage;
- Small difference between various standard IEEE-488.1 and IEEE-488.2;

# Pin description

| Pin 1 | DIO1 | Data input/output bit. | Pin 13 | DIO5 | Data input/output bit. |
|---|---|---|---|---|---|
| Pin 2 | DIO2 | Data input/output bit. | Pin 14 | DIO6 | Data input/output bit. |
| Pin 3 | DIO3 | Data input/output bit. | Pin 15 | DIO7 | Data input/output bit. |
| Pin 4 | DIO4 | Data input/output bit. | Pin 16 | DIO8 | Data input/output bit. |
| Pin 5 | EOI | End-or-identify. | Pin 17 | REN | Remote enable. |
| Pin 6 | DAV | Data valid. | Pin 18 | GND | (wire twisted with DAV) |
| Pin 7 | NRFD | Not ready for data. | Pin 19 | GND | (wire twisted with NRFD) |
| Pin 8 | NDAC | Not data accepted. | Pin 20 | GND | (wire twisted with NDAC) |
| Pin 9 | IFC | Interface clear. | Pin 21 | GND | (wire twisted with IFC) |
| Pin 10 | SRQ | Service request. | Pin 22 | GND | (wire twisted with SRQ) |
| Pin 11 | ATN | Attention. | Pin 23 | GND | (wire twisted with ATN) |
| Pin 12 | SHIELD | | Pin 24 | Logic ground | |