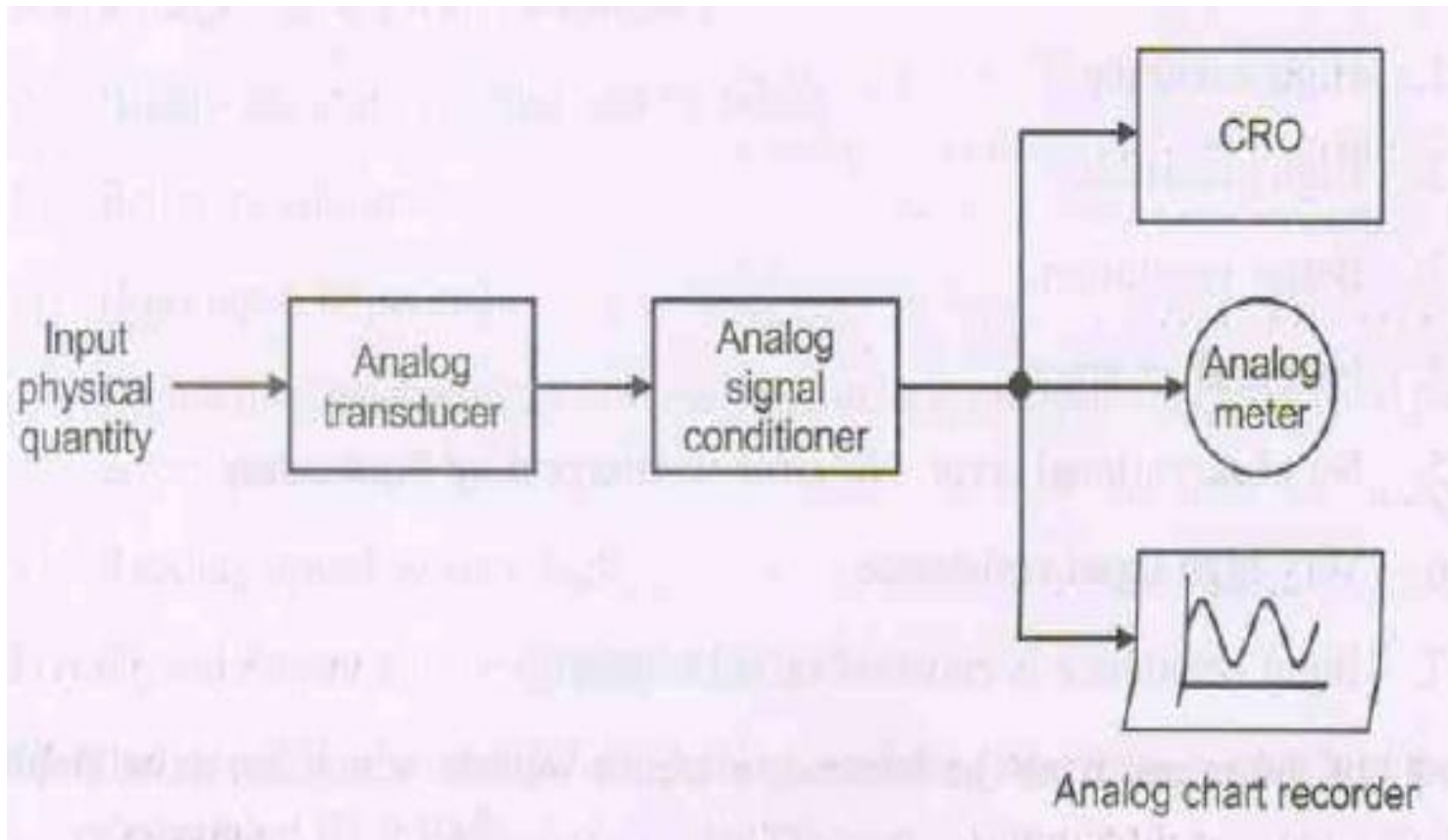


UNIT – V

Analog and Digital Instrumentation

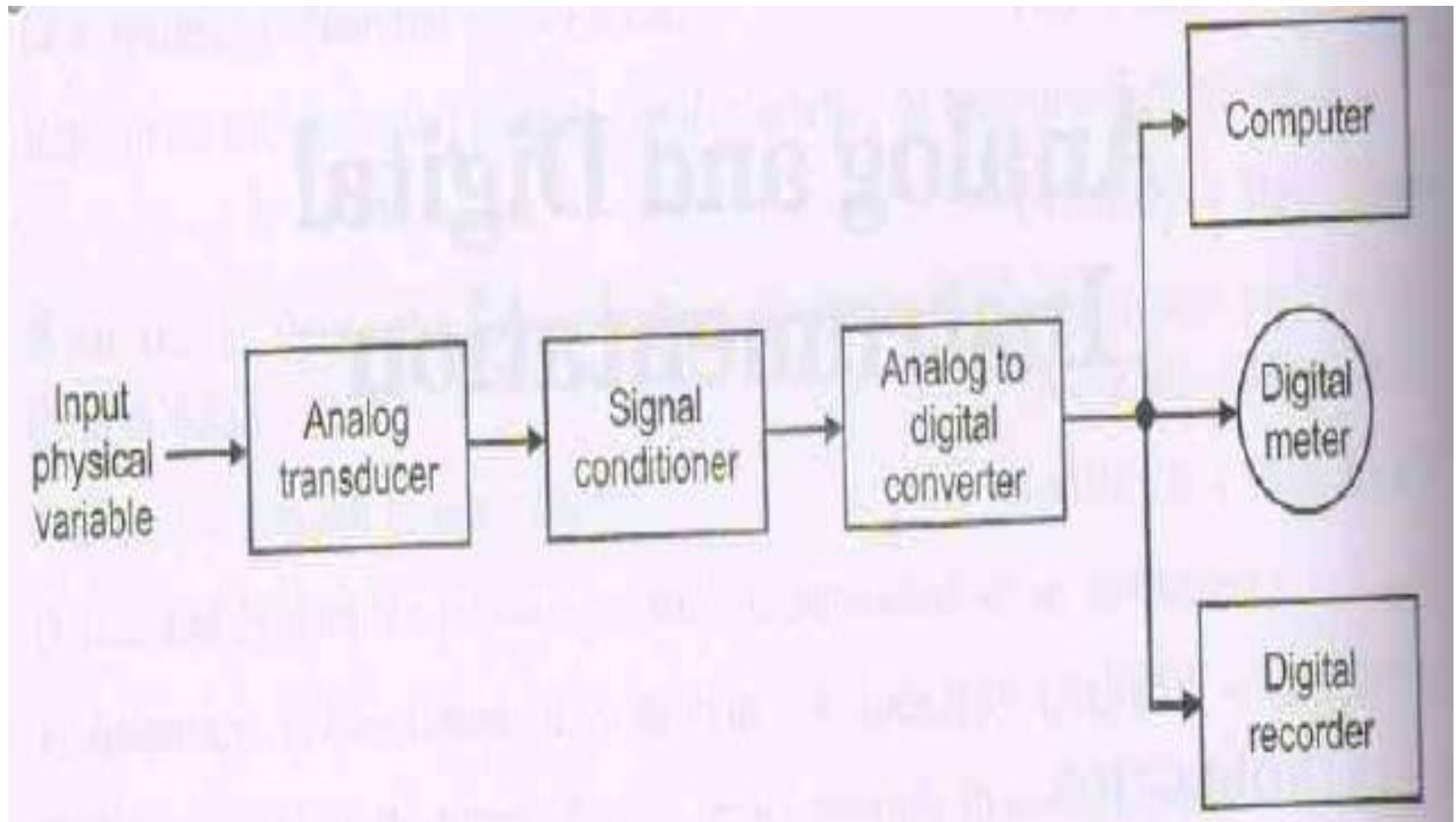
Comparison of Analog and Digital instruments

- Analog measurement system:



Comparison of Analog and Digital instruments

- Digital measurement system:



Advantages of digital meters over analog meters

- High accuracy
- High precision
- Better resolution
- No parallax error
- No observational error. No error in interpreting the reading
- Very high input resistance
- Input resistance is constant on all ranges
- Calibration from the internal reference sources which are quite stabilized
- No waveform error
- Automatic polarity display, automatic zeroing and auto ranging facility are present
- Processing of reading is possible in computer. Reading can be stored and retrieved.

Advantages of digital meters over analog meters

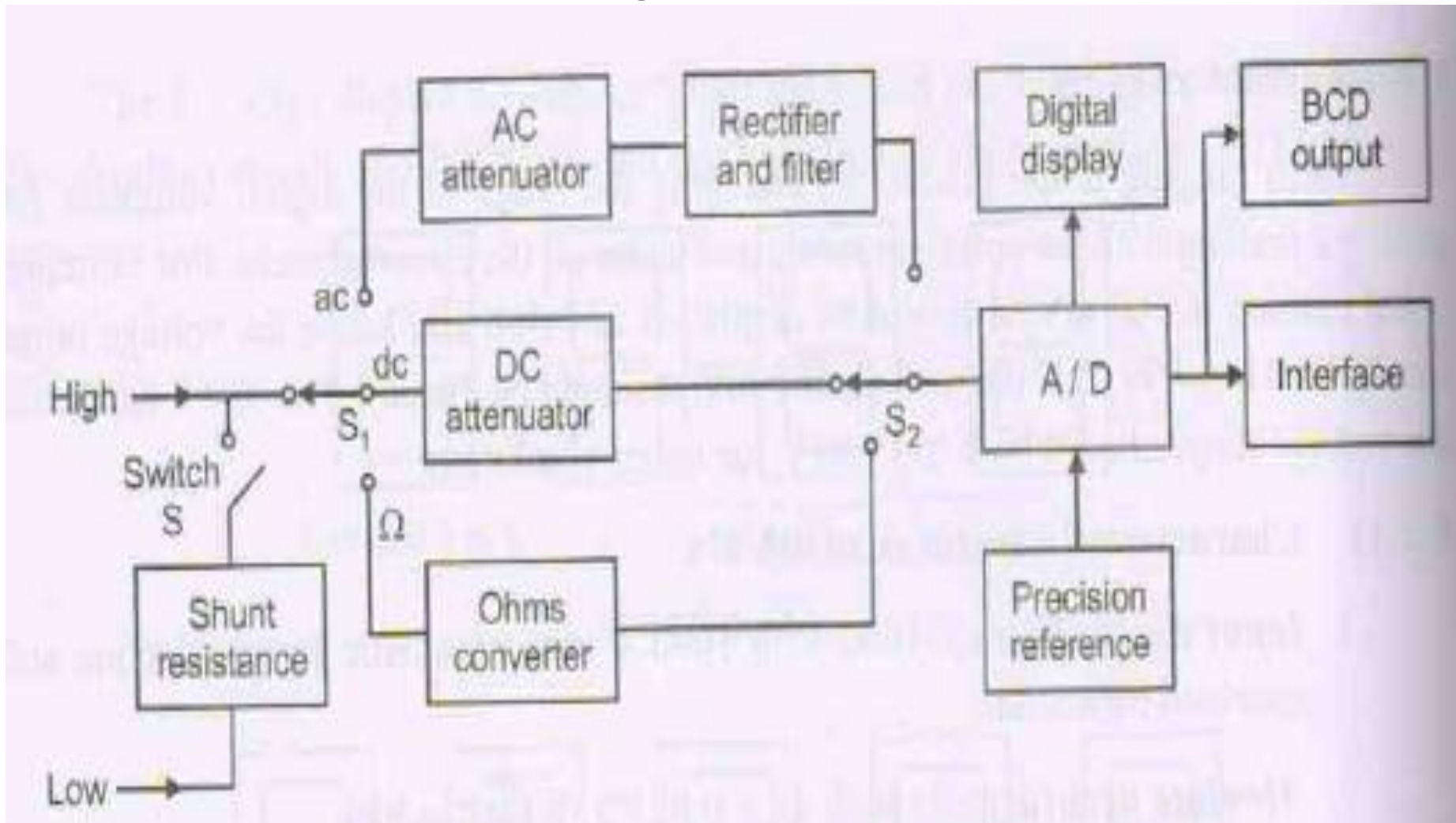
- It can handle wider range of frequency
- A mere push of reset button automatically resets the instrument for new readings
- It is possible to incorporate several instruments into one by digital techniques, and this can be easily programmed
- More rigid and compact. Some expensive multimeter have a special impact resistant holster which protects the meter from damage even if it is dropped on a concrete surface.

Disadvantages of digital meters

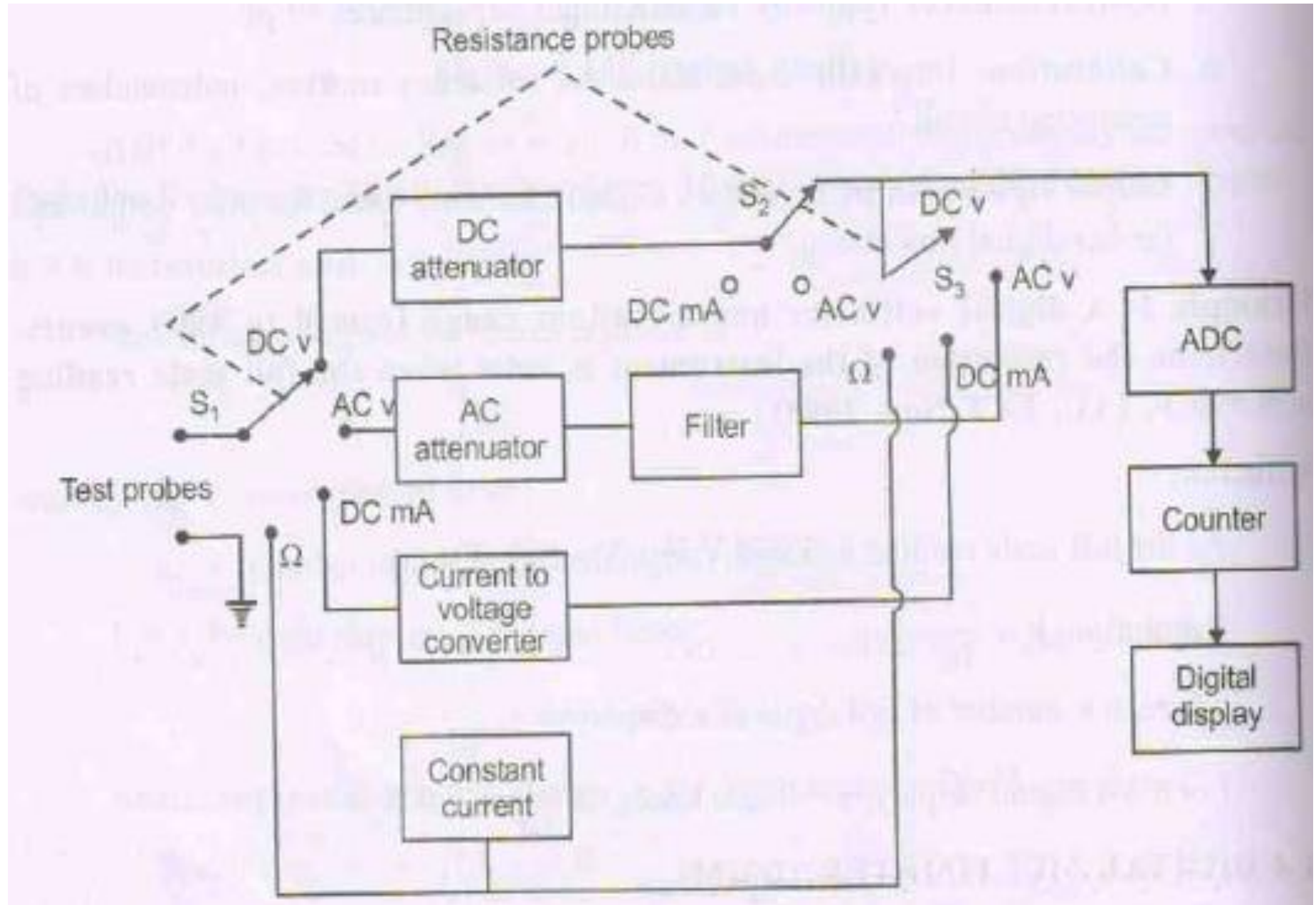
- They need external power supply unit because of the use of ICs.
- Slow change, as occurring in charging of a capacitor, cannot be observed. Analog meter can observe such change as in testing an electrolytic capacitor.
- Testing of diodes cannot be done normally, and a special additional circuit has to be provided for this purpose in some meters.
- Presently expensive, but the cost is decreasing with the development of new ICs.

DIGITAL MULTIMETER (DMM)

- Digital multimeter is an instrument which can be used for measuring d.c and a.c voltages, direct and alternating currents and resistances over several ranges.



DIGITAL MULTIMETER (DMM)



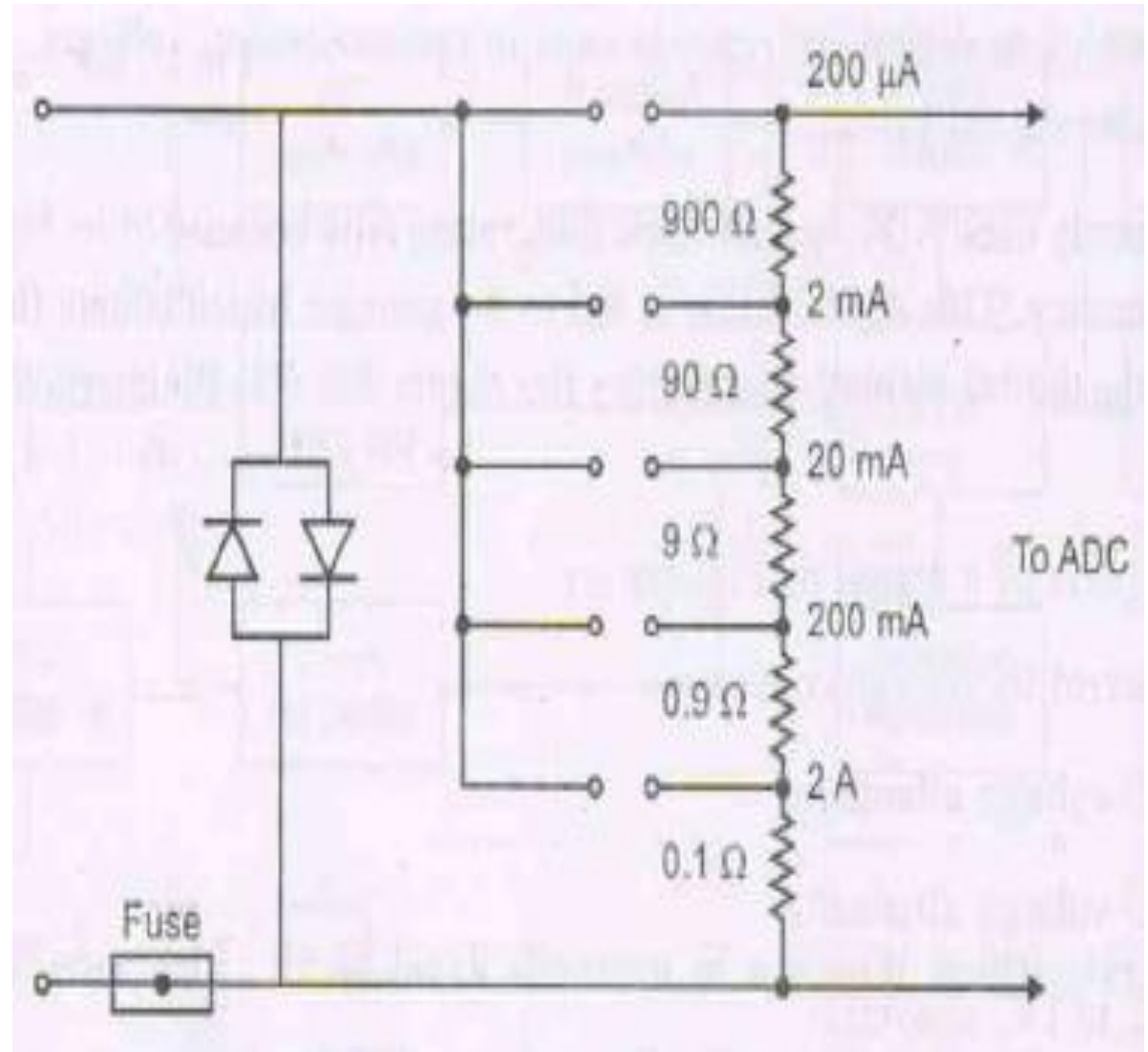
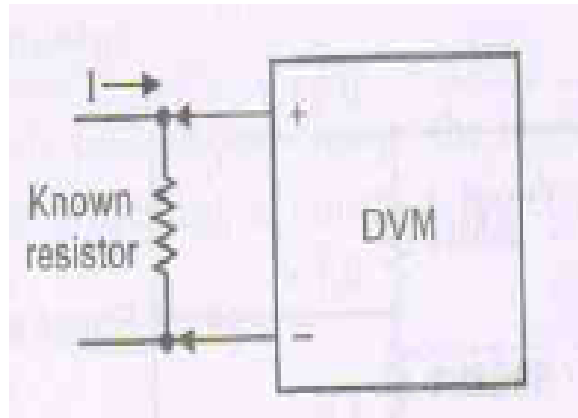
DIGITAL MULTIMETER (DMM)

Main parts of a digital multimeter are

1. Current to voltage converter
2. DC voltage attenuator
3. AC voltage attenuator
4. AC to DC converter
5. Resistance to voltage converter (ohms converter)
6. Analog to digital converter
7. Display devices

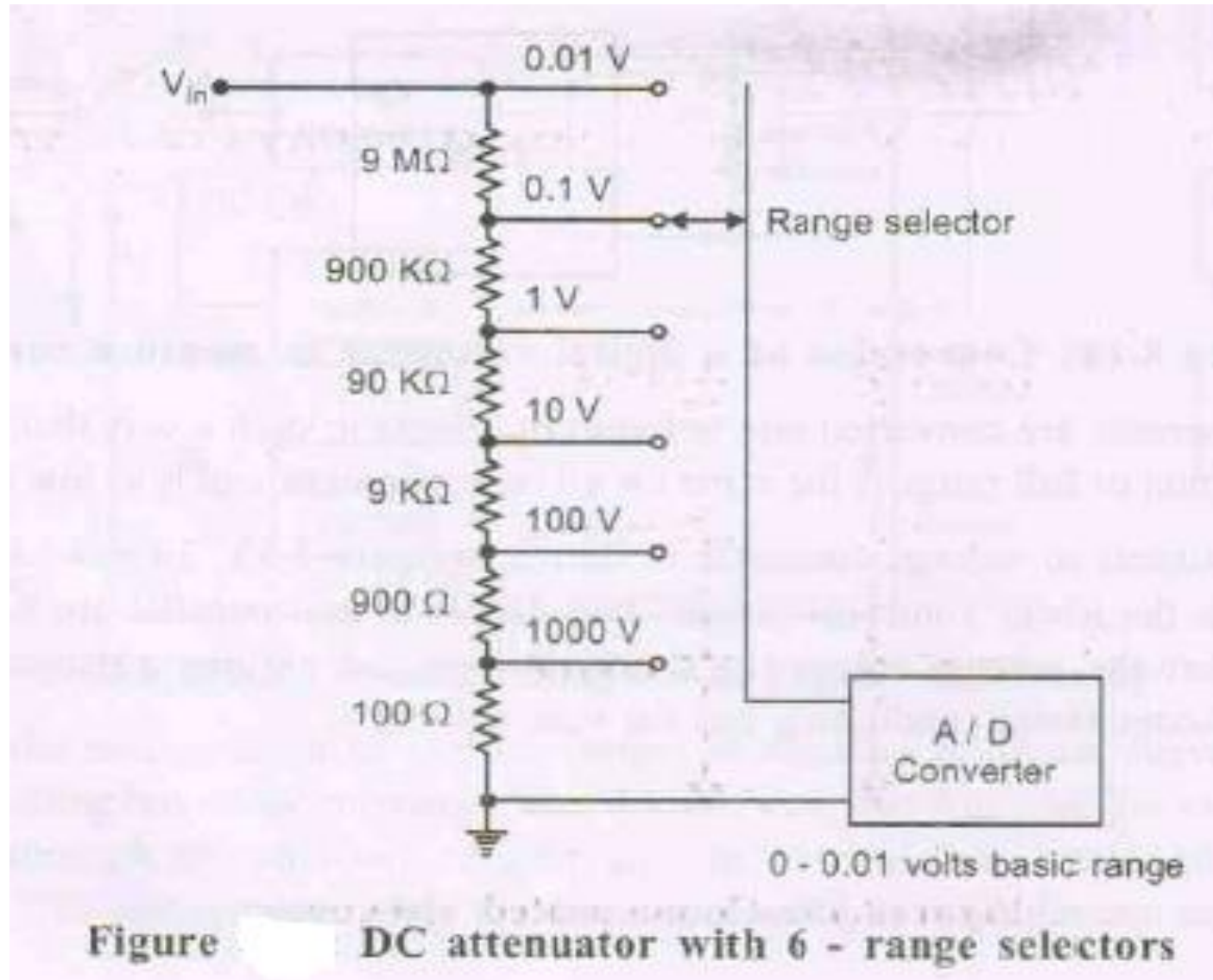
DIGITAL MULTIMETER (DMM)

- Current to voltage converter



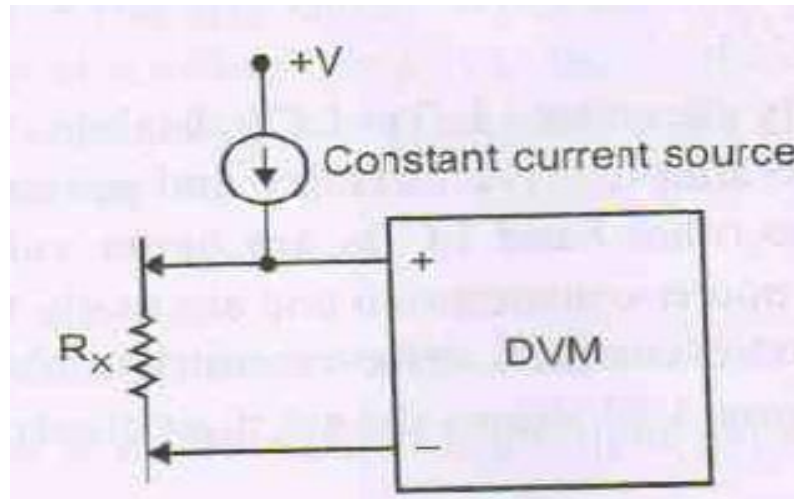
DIGITAL MULTIMETER (DMM)

- DC voltage attenuator:



DIGITAL MULTIMETER (DMM)

- Resistance to voltage converter (ohms converter):



DIGITAL MULTIMETER (DMM)

$$V_0 = \frac{R_x}{R_1} V_m$$

where R_x is the unknown resistance

R_1 is the input resistance.

i.e., the output voltage (V_0) is proportional to the unknown resistance (R_x).

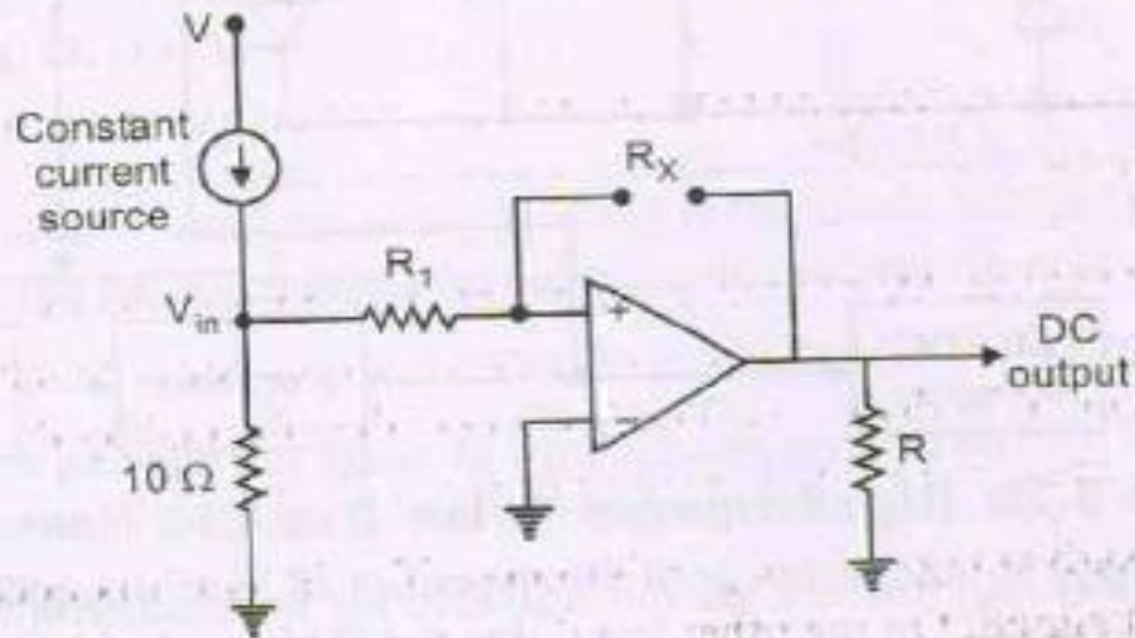


Figure 1 : Resistance to voltage converter using op-amp

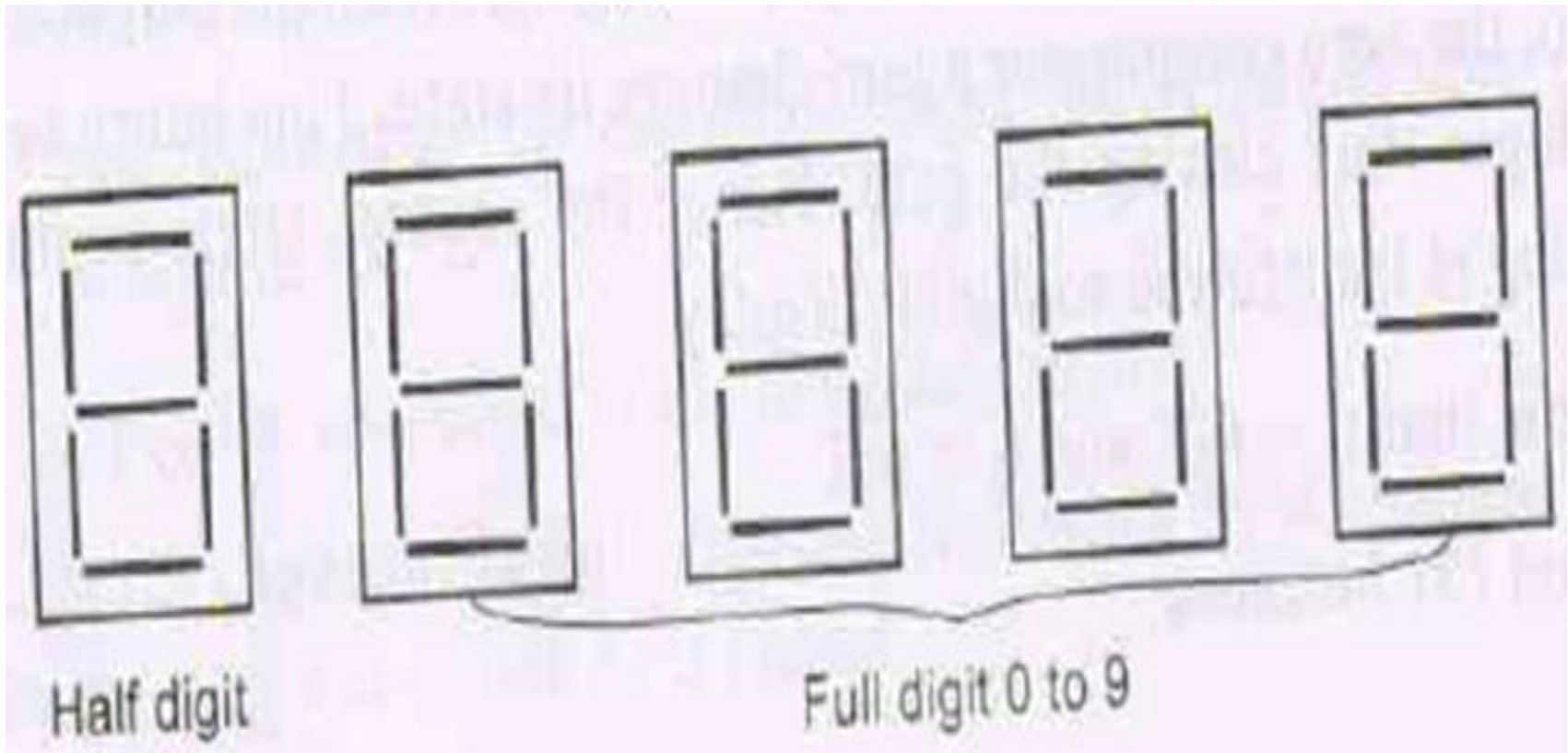
DIGITAL MULTIMETER (DMM)

- Analog to digital converter:

In multimeter the quantities such as DC current, AC current, AC voltage and resistance are converted into DC voltages. This DC voltage is given as an input to the A/D converter and it gives the digital output to the display unit.

DIGITAL MULTIMETER (DMM)

- Display devices:



Advantages of DMM

- Highly accurate and the accuracy is around $\pm 0.03\%$
- Loading effect is nil because of high input impedance.
- Measurement speed is more.
- A single instrument can be used to measure various ranges a.c. and d.c. voltages, alternating and direct current and resistances.
- portable.
- Very cheap.
- Easy to interface with other devices.
- Resolution is high in the order of $10/\mu\text{V}$.

Disadvantages of DMM over analog instruments

- Interruption of electric noise.
- Requirement of external power supply.
- Isolation problem occurs in DMM.

Storage Oscilloscope

- A storage oscilloscope can retain the trace caused by a single sweep for a long period of time. This feature is practically useful in studying non-repetitive events such as turn-on transients or very low speed phenomenon where the required sweep time is very long compared to the persistence of the standard oscilloscope phosphor.

Storage Oscilloscope

- There are two basic methods used for retaining a trace on the oscilloscope screen for a long period of time.
- One method makes use of storage oscilloscope with special CRTs and the other uses a digital storage oscilloscope.

Analog storage Oscilloscope

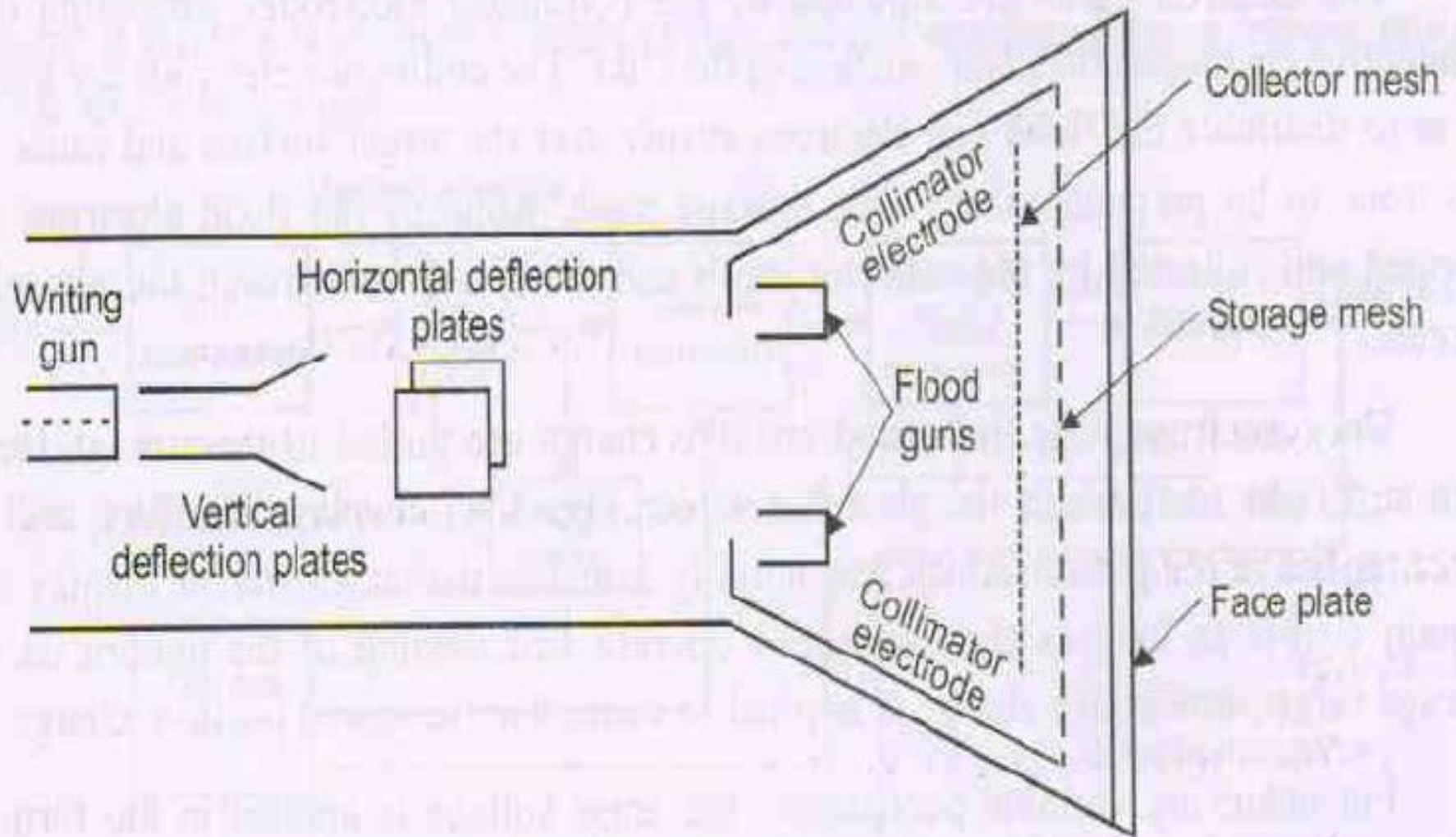
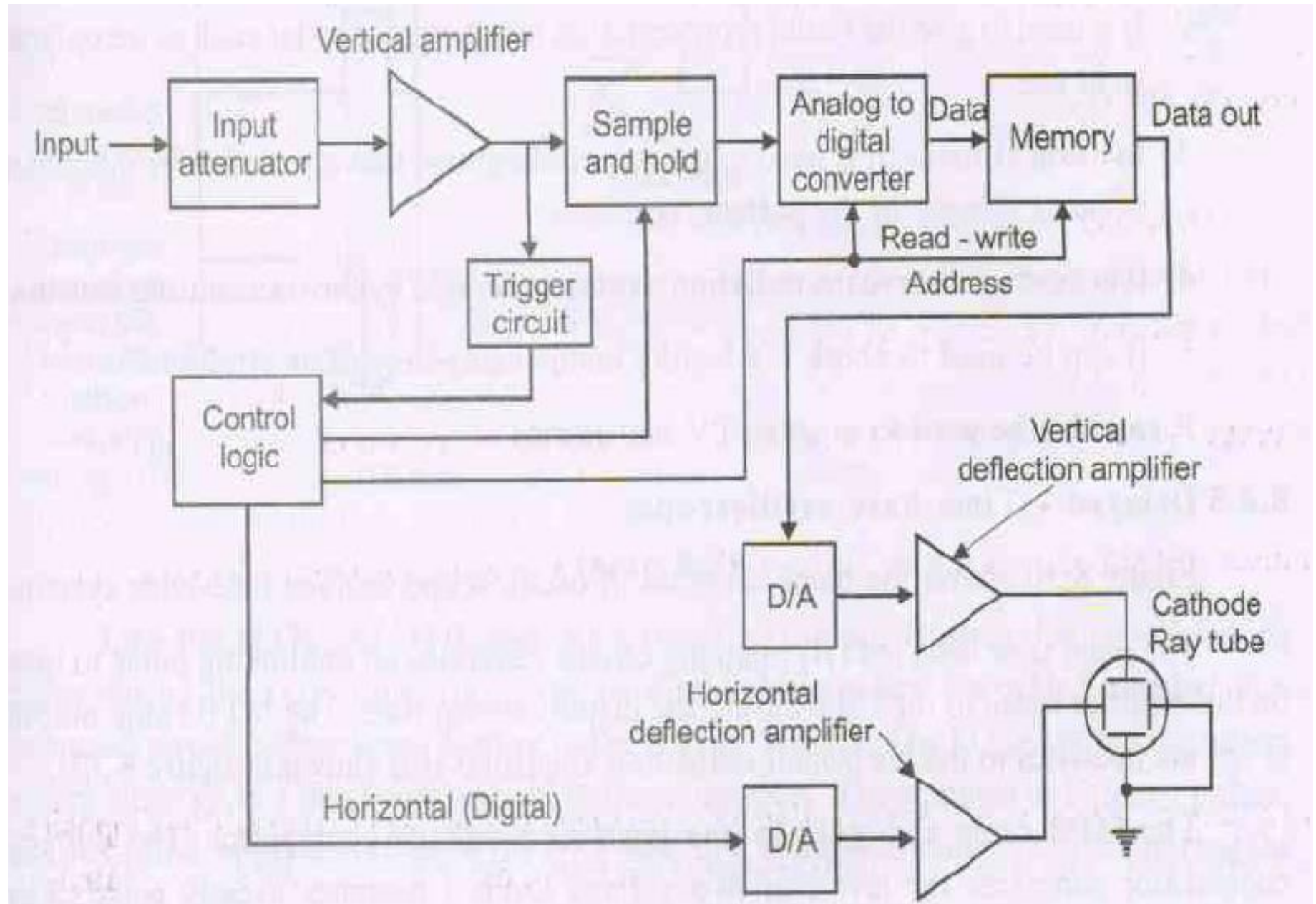


Figure 1.1 Mesh storage CRT

Digital Storage Oscilloscope



Digital Storage Oscilloscope

Advantages

1. Infinite storage time.
2. Easy to operate.
3. Pretriggering feature allows display of waveform, before the trigger pulse.
4. Signal processing is possible.
5. Cursor measurement is possible.
6. It is capable of displaying X-Y plots, P-V diagrams and B-H curve.
7. A number of traces depending on the memory size can be stored and recalled.

Digital Storage Oscilloscope

Applications

1. It can be used to measure
 - i) AC as well as DC voltages and currents.
 - ii) Frequency, time period, time interval between two signals etc.
 - iii) Inductance, capacitance.
 2. It is used to give the visual representation for a target of radar such as aeroplane, strip etc.
 3. In medical fields, it is used to display cardiograms that are useful for diagnosis of heart disease in the patient.
 4. It is used to observe the radiation pattern generated by the transmitting antenna.
 5. It can be used to check the faulty components in various circuits.
- It can also be used to analyze TV waveforms.