Electronic Instrumentation

Applications of Digital Storage Oscilloscope(DSO)
And
Digital multimeter

Capt.Dr.A.Veeraiah
Department of Physics
D.N.R.College(A) :: Bhimavaram
Phone :8143395467, E-Mail:avruavru@gmail.com

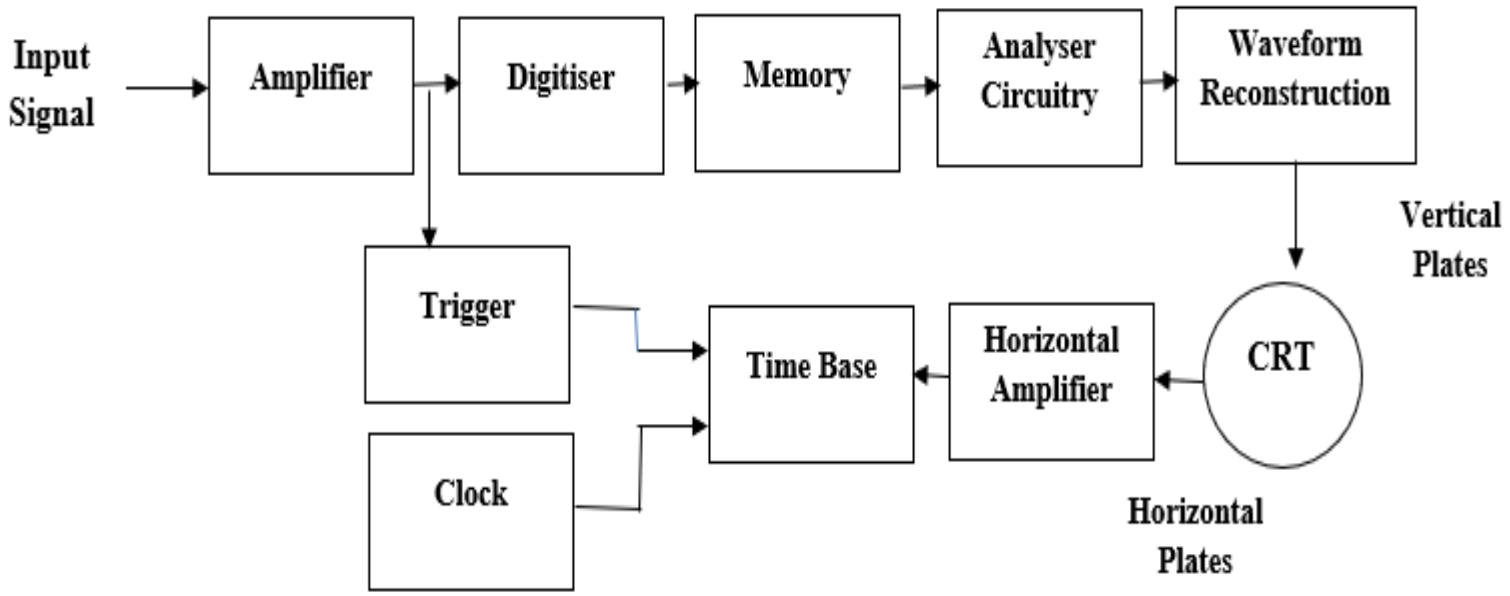
Digital storage oscilloscope

- A **digital storage oscilloscope** (**DSO**) is an oscilloscope which stores and analyses the input signal digitally rather than using analog techniques. It is now the most common type of oscilloscope in use because of the advanced trigger, storage, display and measurement features which it typically provides.

Digital storage oscilloscope

- It gives digital copy of the waveform
- It allows us to store the digital waveform
- It gives us the visual display of the waveforms
- It accepts analog signal
- It converts analog signal into a digital one
- It stores it in the digital memory
- It is again converted into analog form and displays on the screen.

BLOCK DIAGRAM OF DSO



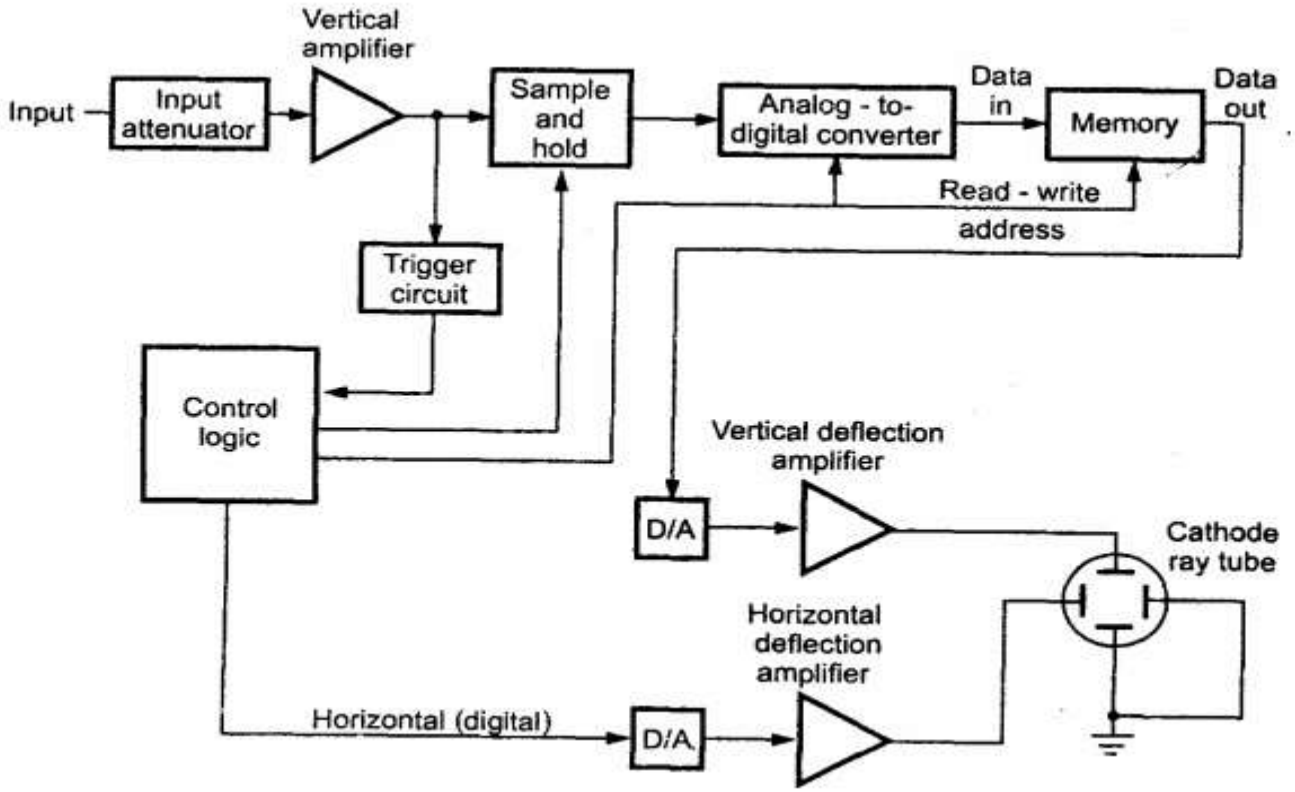
Working

- Amplify the signal
- Digitized(A to D conversion)
- Stored in memory
- Analyser circuitry (processing is done)
- Waveform reconstruction(digital wave in reproduced in analog form
- Supplied to vertical plates

Working..

- Trigger input and clock input
- In DSO, two inputs are there
- Time base circuitry
- Horizontal amplifier

Widely used circuit



Working

- Attenuator attenuates(noise if any) the input signal
- Control logic produces time base signal which is mostly a microprocessor. It performs all the control logics in the circuits

Working

- The input signal is applied to the Amplifier and attenuator section
- The attenuated signal is then given to the vertical amplifier. Then is connected to analog to digital converter(digitise the analog signal)
- Create a data set that is stored in the memory
- Data set is processed by the microprocessor and then sent to the display

Working of DSO

- At first digital storage oscilloscope digitizes the analog input signal, then the analog input signal is amplified by amplifier if it has any weak signal.
- After amplification, the signal is digitized by the digitizer and that digitized signal stores in memory.
- The analyzer circuit process the digital signal after that the waveform is reconstructed (again the digital signal is converted into an analog form) and then that signal is applied to vertical plates of the cathode ray tube (CRT).

Working of DSO

- The cathode ray tube has two inputs they are vertical input and horizontal input.
- The vertical input signal is the 'Y' axis and the horizontal input signal is the 'X' axis.
- The time base circuit is triggered by the trigger and clock input signal, so it is going to generate the time base signal which is a ramp signal.
- Then the ramp signal is amplified by the horizontal amplifier, and this horizontal amplifier will provide input to the horizontal plate.
- On the CRT screen, we will get the waveform of the input signal versus time.

Working of DSO

- The digitizing occurs by taking a sample of the input waveform at periodic intervals.
- At the periodic time interval means, when half of the time cycle is completed then we are taking the samples of the signal.
- The process of digitizing or sampling should follow the sampling theorem.
- The sampling theorem says that the rate at which the samples are taken should be greater than twice the highest frequency present in the input signal.
- When the analog signal is not properly converted into digital then there occurs an aliasing effect.

Working of DSO

- When the analog signal is properly converted into digital then the resolution of the A/D converter will be decreased.
- When the input signals stored in analog store registers can be read out at a much slower rate by the A/D converter, then the digital output of the A/D converter stored in the digital store, and it allows operation up to 100 mega samples per second.
- This is the working principle of a digital storage oscilloscope.

DSO Operation Modes

- The digital storage oscilloscope works in three modes of operations they are roll mode, store mode, and hold or save mode.

1) **Roll Mode:** In roll mode, very fast varying signals are displayed on the display screen.
2) **Store Mode:** In the store mode the signals stores in memory.
3) **Hold or Save Mode:** In hold or save mode, some part of the signal will hold for some time and then they will be stored in memory.

Note: Digitising occurs by taking a sample of the input waveform at periodic interval of time

Sampling theorem

- Sampling rate must be at least twice as fast as the highest frequency in the input signal
- Aliasing: resolution of A/D converted is decreased analog store.

- When input signals are stored in analog store register, they can be read out a a much slower rate to the A/D converter and the results are stored in digital store
- Allows operation upto 100 mega samples per second

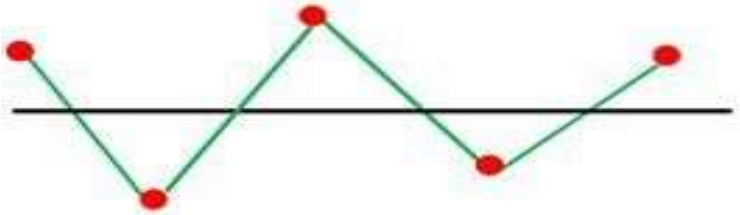
Waveform Reconstruction

- There are two types of waveform reconstructions they are linear interpolation and sinusoidal interpolation.

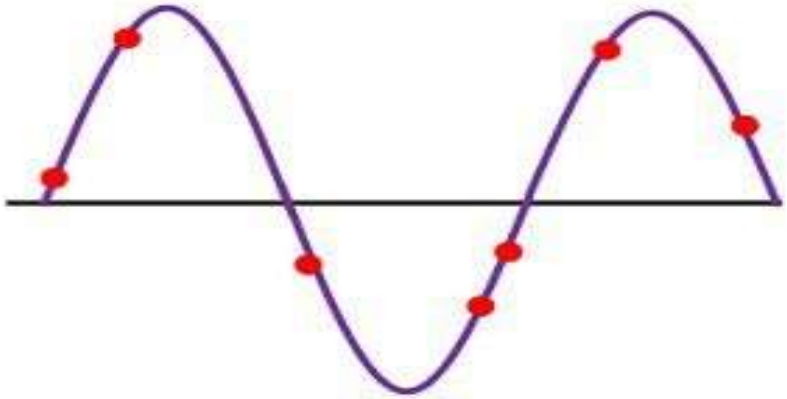
1. **Linear Interpolation:** In linear interpolation, the dots are joined by a straight line.
2. **Sinusoidal Interpolation:** In sinusoidal interpolation, the dots are joined by a sine wave.

Waveform reconstruction

(a) Without Interpolation



(b) Linear Interpolation



(c) Sinusoidal Interpolation

Difference Between Digital Storage Oscilloscope and Conventional Storage Oscilloscope

S.NO	Digital Storage Oscilloscope	Conventional Storage Oscilloscope
1	The digital storage oscilloscope collects data always	After triggering only, the conventional storage oscilloscope collects data
2	The cost of the tube is cheap	The cost of the tube is costlier
3	For higher frequency signals the DSO produce bright images	For higher frequency signals the ASO cannot produce bright images
4	The resolution is higher in digital storage oscilloscope	The resolution is lower in conventional storage oscilloscope
5	In DSO an operating speed is less	In ASO an operating speed is less

Applications of DSO

1. It checks faulty components in circuits
2. Used in the medical field
3. Used to measure capacitor, inductance, time interval between signals, frequency and time period
4. Used to observe transistors and diodes V-I characteristics
5. Used to analyze TV waveforms
6. Used in video and audio recording equipment's
7. Used in designing
8. Used in the research field
9. For comparison purpose, it displays 3D figure or multiple waveforms
10. It is widely used an oscilloscope

Advantages of DSO

- Portable
- Have the highest bandwidth
- The user interface is simple
- Speed is high

Disadvantages of the DSO

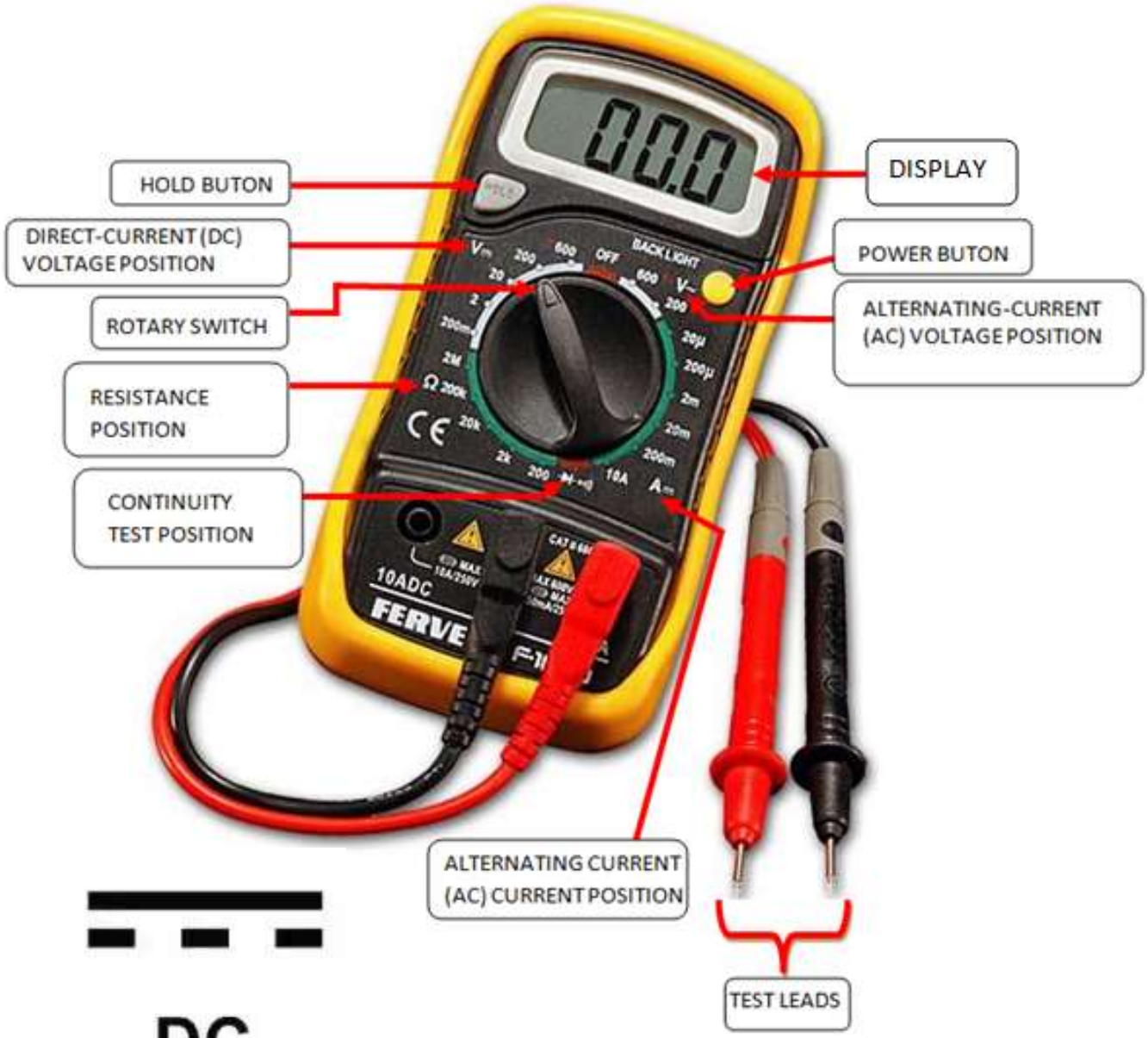
- Complex
- High cost

Digital Multimeter

- It is a basic instrument which is used for measurement of dc and ac voltages, currents, resistances, etc.,.. Over a wide range.
- It has two important terms--------

1. Multi: Indicates that a single device is used for multi purpose measurements.
2. Digital: Indicates that the device has a digital or LCD output

Digital Multimeter


HOLD BUTON
DIRECT-CURRENT (DC) VOLTAGE POSITION
ROTARY SWITCH
RESISTANCE POSITION
CONTINUITY TEST POSITION
DISPLAY
POWER BUTON
ALTERNATING-CURRENT (AC) VOLTAGE POSITION
ALTERNATING CURRENT (AC) CURRENT POSITION
TEST LEADS
10ADC
FERVE
AC
DC

Parts of digital multimeter

- Display screen- it has an illuminated display screen for better visualisation
- Five digits-

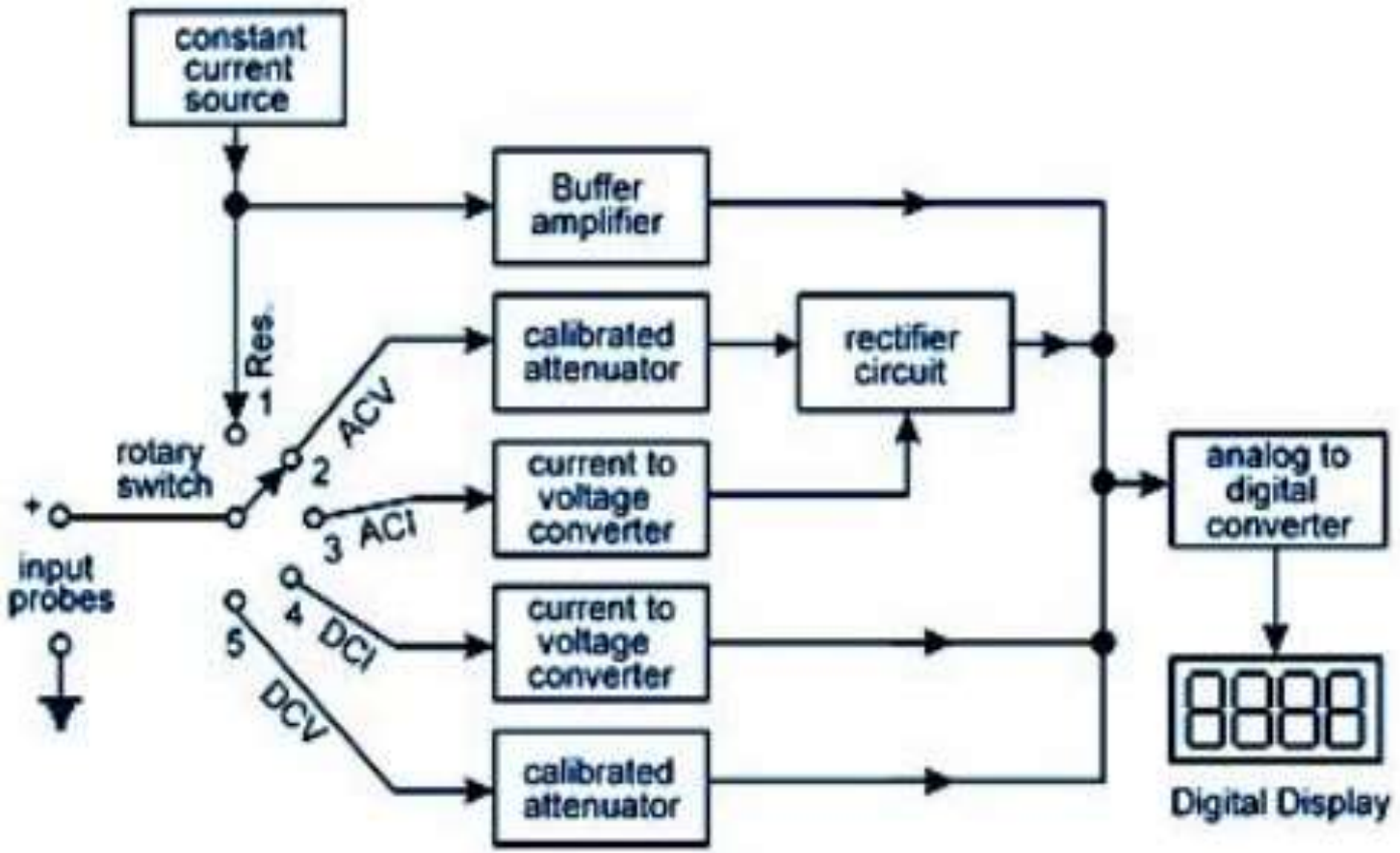
1. one for sign value(+ or -)
2. Four for number representation

Parts of Multimeter

- Selection knob: multimeter is used for several measurements like voltage, current and resistance. The selection knob allows the user to select the different measurements
- Ports : two ports

1. Com port(Black probe): It is negative
2. mAVΩ port(Red probe):It is positive
3. 10A current port: it is used for measuring large currents.

DMM block diagram



Various parts

- Resistance
- ACV(Alternating voltage)
- ACI (Alternating current)
- DCI (Direct current)
- DCV(Direct Voltage)

DMM…

- The current is converted into voltage by passing it through low shunt resistance
- The AC quantities are converted into DC quantities by employing various rectifier and filtering circuits
- The resistance measurements consist of a low current source that is applied across an unknown resistance.

Applications of DMM

- Measurement of voltage: For measurement of voltage, the input voltage is fed through a calibrated, compensated attenuator, to a precision fullwave rectifier followed by a ripple reduction filter. A/D converter

Applications of DMM

- Measurement of current: For current measurement, the drop across an internal calibrated shunt is measured directly by the ADC in the "DC current mode" and after AC to DC conversion in the "AC current mode"
- Resistance voltage drop

  I=V/R

Applications of DMM

- Measurement of Resistance:

  Digital multimeter measures voltage across the externally connected resistance, resulting form a current forced through it from a calibrated current source

Thank you