Instrumentation - computer Engg

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Date

Page

Unit - III [7 hrs]

Electrical signal processing and data Acquisition

Basic OP-amp^n chactoristics:-

1. High voltage gain.
2. High input Impedance.
3. Low output Impedance.
4. High common mode Rejection Ratio [CMRR].
5. Small signal bandwidth.
6. Low output voltage swing.
7. perfect Balanced.
8. High slew rate.

Instrumentation amplifier :-

Instrumentation amplifier is a kind of Differential amp^n.

9. Gain stability
10. Input Impedance Maching.

For, Design

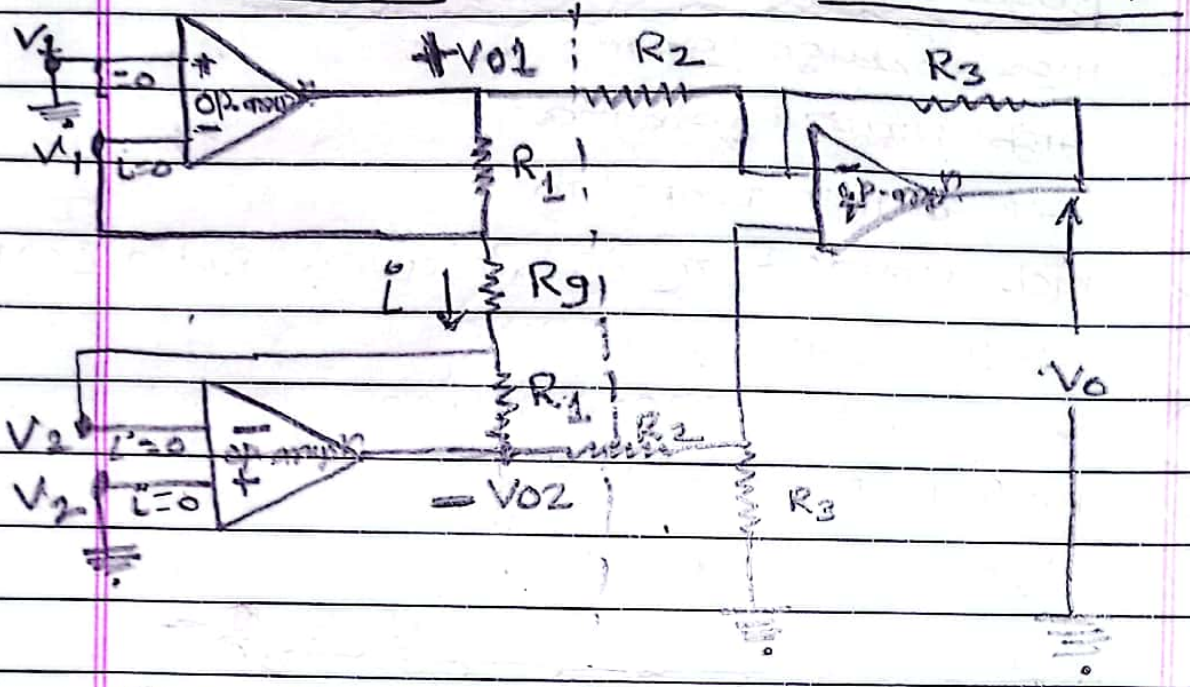
a. To Low d.c. offset.
b. Low drift.
c. Low Noise.
d. Very high open LOOP gain.
e. Very high open LOOP CMRR.
f. Very high input impedance.

The ckt diagram of Instrumentation amp^n

CKT

Buffer

Differ. c c amp^n



[fig-③ Instrumentational amp^n]

$$V_o = \frac{R_3}{R_2}[V_{o2} - V_{o1}] \quad \text{——} \quad (1)$$

Let, assume,

$$V_1 > V_2$$

some current passing through V_{o1} and V_{o2} path. I know, i current flowing through higher potential to lower potential

$$i = \frac{V_1 - V_2}{R_g} \quad \text{——} \quad (2)$$

Assume, V_{o1} is higher potential to lower potential at V_{o2}.

Appling the ohm's Law :-

$i = V/R = \frac{\text{voltage difference}}{\text{Total resistance}}$ [Date Page V.D]

$i = \frac{V_{o1} - V_{o2}}{R_1 + R_g + R_1}$

$i = \frac{V_{o1} - V_{o2}}{2R_1 + R_g}$

$\frac{V_1 - V_2}{R_g} = \frac{V_{o1} - V_{o2}}{2R_1 + R_g}$

$\therefore V_{o1} - V_{o2} = \frac{2R_1 + R_g}{R_g}[V_1 - V_2]$

[Taking - sign common]

$V_{o2} - V_{o1} = \left[1 + \frac{2R_1}{R_g}\right][V_2 - V_1]$ ——— (3)

Substituting eqn (3) in eqn (1)

$\therefore V_o = \frac{R_3}{R_2}\left[1 + \frac{2R_1}{R_g}\right][V_2 - V_1]$

$$\boxed{\frac{V_o}{V_2 - V_1} = \frac{R_3}{R_2}\left[1 + \frac{2R_1}{R_g}\right]}$$

$\Downarrow$

$$\text{Gain} = \frac{R_3}{R_2}\left[1 + \frac{2R_1}{R_g}\right] \leftarrow \text{output voltage}$$

Advantage of Instrumentation amp^n :-

(1) Accurate and stable resistive Feedback N/w to gives a desired gain.

(2) Due to closed loop configuration used, sothat Instrumentation amp^n can used to directly for amplifying the signal by

fixed amplification factor

③ The gain accuracy, gain stability and drift performance are normally specified by the manufactures

④ CMRR specified which is only applicable for very Low source impedance

⑤ Low DC offset, low noise, Low drift high open loop gain, high slow rate, high input impedance.

signal amplification :-

① The signal amplifier is a ckt that used the electrical power to increase the amplitude of an incoming signal voltage or signal current. output of this higher amplitude.

② The ideal signal amp^n creates an exact replica of original signal that is larger but identical in every other way. In practice a perfect amp^n is not possible.

③ signal amp^n are an essential component of thousand of device. Like, Landline, Cellular telephone, music and public address system. DAQ system, radio - freq - transmit ex: servo motor controller.

④ In data [DAQ] system, signal amplifiers need to increase the amplitude, from Transducer the output small signals, sent to ADC.

⑤ some common signal amp^n in data acquisition systems.

⑥ voltage amp^n :-
- ⓐ High voltage amp^n
- ⓑ Low voltage amp^n
- ⓒ D.C voltage amp^n
- ⓓ A.C voltage amp^n.

⑦ current amp^n :-

⑧ charge amp^n :-

⑨ Isolated amp^n :-

⑩ Differential amp^n :-

⑪ strain gauge amp^n :-
- ⓐ Bridge amp^n
- ⓑ Full-Bridge amp^n
- ⓒ Half-Bridge amp^n.
- ⓓ Quarter-Bridge amp^n.

⑫ Thermocouple amplifiers.

Attenuation :-

Attenuation, the opposite of amplification is necessary when voltage to be digitized are beyond the ADC range. This form of signal conditioning decreases input signal amplitude.

so that conditioned signal is within ADC range. Attenuation is typically necessary when measuring voltages that are more than 10V.

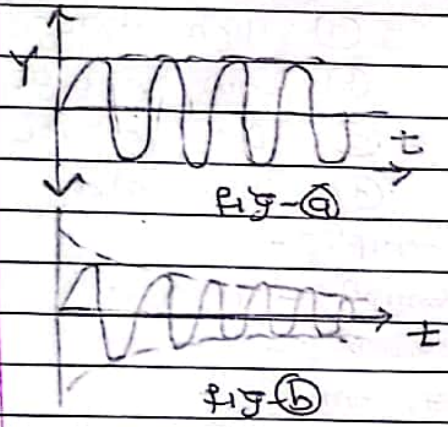


Fig-(a)

Fig-(b)

Attenuation is one of the technique used in signal conditioning to scale down the amplitude or voltage level of a signal to ... match the input range or requirement of down-stream components or systems.

Attenuation can be achieved using passive or active components within a signal conditioning ckt.

(1) Active attenuation :-
(2) passive attenuation :-
(3) Active attenuation :- Active-attenuation involves the use of active components such as the op^m amp^n to actively amplify or attenuate the signal. In case of attenuation, an op^m amp^n can be configured as an inverting amp^n or a voltage follower with appropriate gain settings to achieve the desired signal reduction.

Attenuation in signal conditioning is often used to protect sensitive component from excessive signal levels, prevent signal clipping or saturation, or match signal level between different stages of the system. ie A/D converters where input voltage range is limited, attenuation can be applied to scale down the input signal to fit within the A/D range without losing important information.

(2) passive attenuation :- The passive attenuation techniques typically involve the use of voltage divider. The voltage divider ckt is commonly example of passive attenuation. Where output voltage is a fraction of the input voltage determined by the resistor values.

ⓐ Attenate the applied wave.

ⓑ Alter the d.c level of the applied wave.

ⓒ The wave shaping teenique include clipping and clamping.

clippers :-

A clipper is an electronic ckt that produced an output by removing a part of the input above or below a ref^{n} level. In otherwords clippers ckt is electronic ckt that limits or clips the amplitude of a waveform at certain level.

The clippers ckt is classified on the base of the clipping portion of the input :.

ⓐ positive clipper

ⓑ Negative clipper

ⓒ positive clipper :- The positive clipper that clips only the positive portion of the input signal.

[fig- ⓐ sinusoidal input signal]

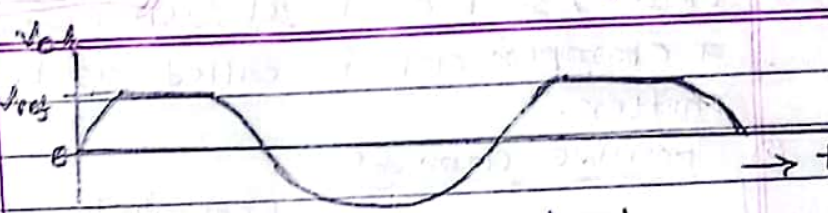


fig-ⓐ output signal

ⓑ Negative clipper :. A Negative clipper is a clipper that clips only the Negative portion of the input signal.

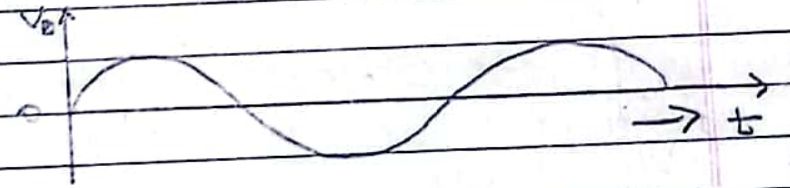


fig-ⓐ sinusoidal Input signal.

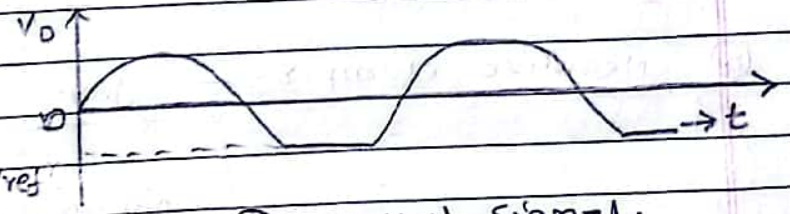
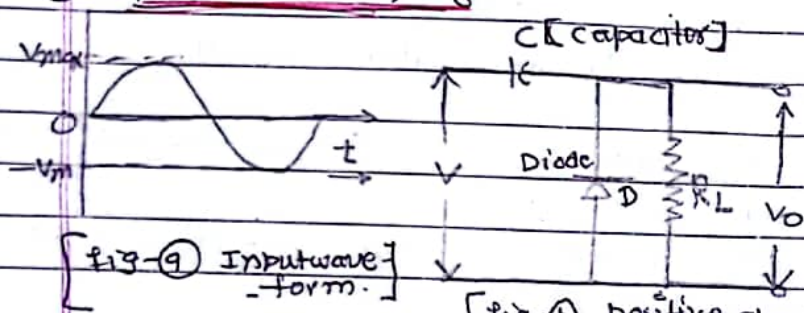


fig-ⓑ output signal.

Clamper ckt :- A clamper ckt is a ckt that adds a D.C. level to an AC signal. Acturally, the positive and negative peaks of the signals can be placed at desired levels using clamping

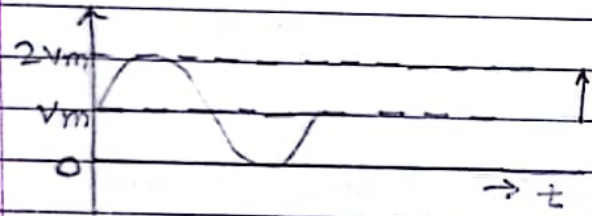
ckts. As D.C. level get shifted a clamper ckt is called as Level shifter.

(a) positive clamper :-



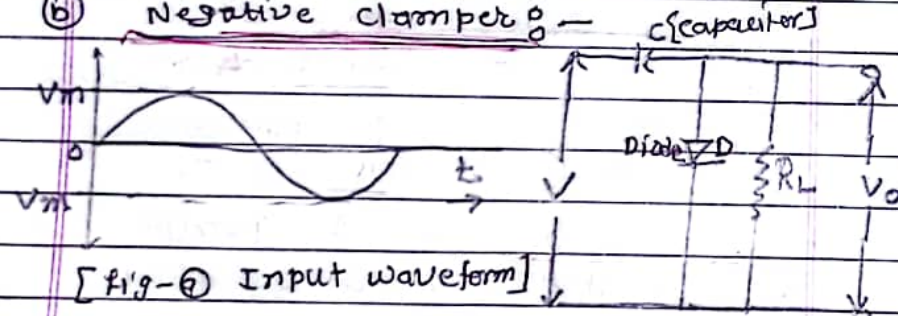
[fig-(a) Inputwave-form.]

[fig-(b) positive clamper]



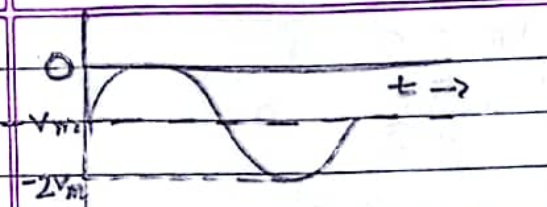
[fig-(c) output waveform]

(b) Negative clamper :-



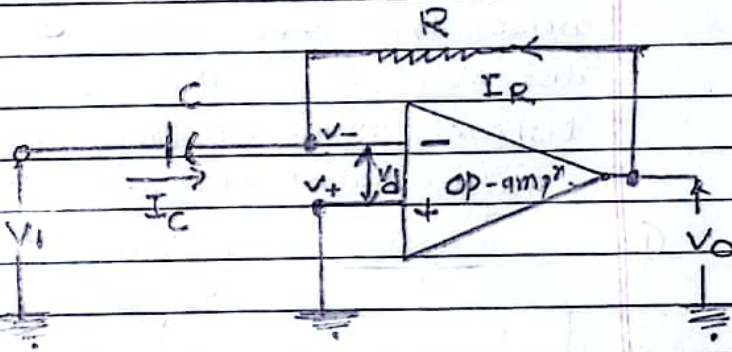
[fig-(a) Input waveform]

[fig-(b) Negative clamper]



[fig-(c) output waveform]

Differentiation :- It is function is to provide an output voltage proportional to the rate of change of input voltage. It is the inverses mathematical operation to that of an integrator. It also provides information about the instantaneous change in signal.



[fig-(a) Differentiator ckt]

$V_+ = 0$, $V_+ - V_- = 0$,

$V_- = 0$

Applying KCL at node, V-

$$I_C + I_R = 0$$

$$C\frac{d[V_i]}{dt} + \frac{V_o}{R} = 0$$

$$C\frac{d[V_i]}{dt} = -\frac{V_o}{R}$$

$$\frac{V_o}{R} = -C\frac{d[V_i]}{dt}$$

$$\boxed{V_o = -RC\frac{d[V_i]}{dt}}$$

output voltage

The output voltage is equal to the differentiated input voltage. A differentiator is used in analog computer as it tends to amplify noise drift and other unwanted distrubance in the system.

Differents types of Input signal in Differentater CKTs :-

① sine-wave :-

fig-ⓐ sine-wave Input-signal

fig-ⓑ cosine-wave output signal

②

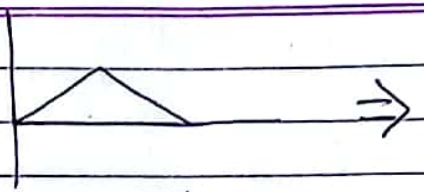


fig-ⓐ Trinagular-wave Input-signal

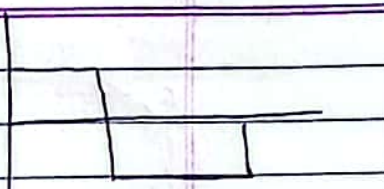


fig-ⓑ Rectangular wave output signal.

③

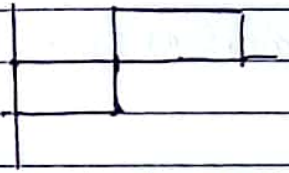


fig-ⓐ square-wave Input-signal

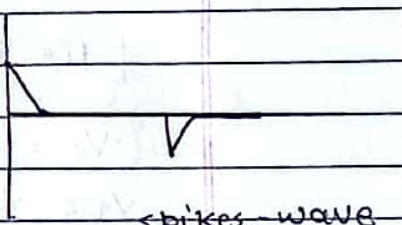
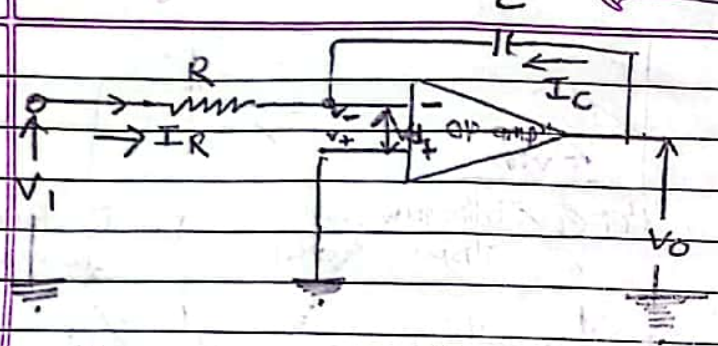


fig-ⓑ spikes-wave output-signal.

Integration :- An integrator is a CKT that performs a mathematical operation called integration. Integration is continuous addition. The most popular application of an integrator is to produced a ramp of output voltage which is linearly increasing or decreasing voltage. A CKT in which the output voltage is proportional to the integral of input voltage, shown in fig- ⓐ below.



[fig-ⓐ op-amp as Integrator]

$V_+ = 0$

$V_+ - V_- = 0$

$V_- = 0$

Applying the KCL at node V_-

$I_R + I_C = 0$

$\frac{V_1}{R} + C\frac{dV_o}{dt} = 0$

$C\frac{dV_o}{dt} = -\frac{V_1}{R_1}$

$\frac{dV_o}{dt} = -\frac{V_1}{R_1 C}$

Taking $\int$ing both sides

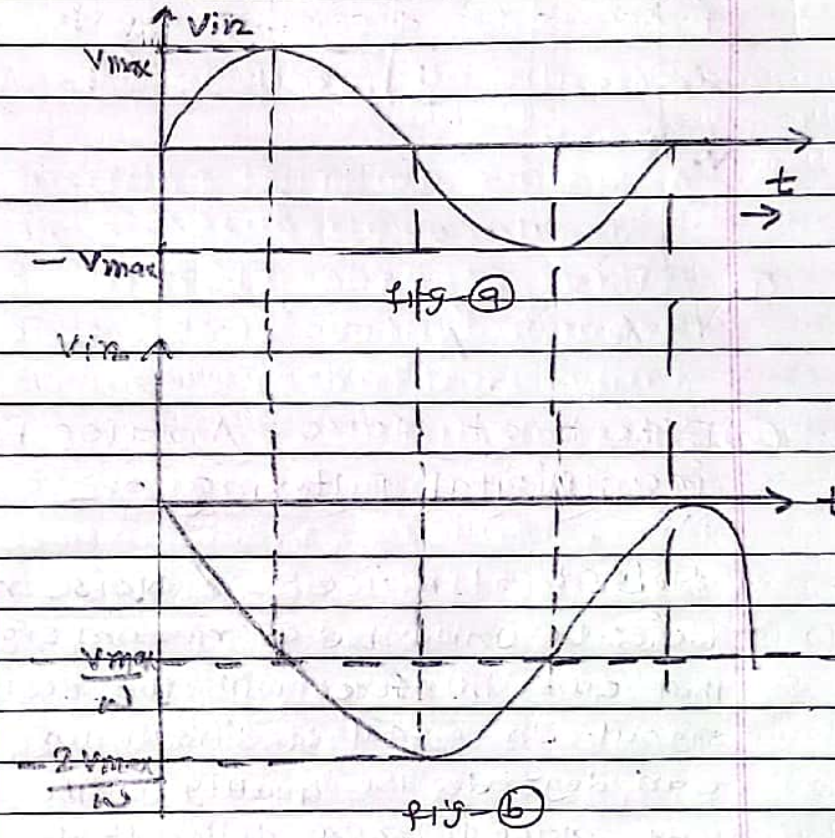
$\int \frac{d(V_o)}{dt}\,dt = -\int \frac{V_1}{R_1 C}\,dt$

$$\boxed{V_o = -\frac{1}{RC}\int V_1\,dt}$$

The convenient values of R_1 and C are MΩ or μF range.

Let, consider different types of Input signal's -

① Let $V_{in} = V_m \sin\omega t$ [sinwave]



② Let, V_{in} = step signal

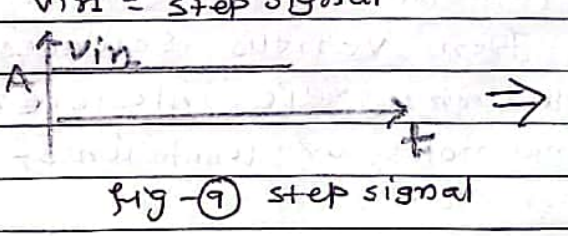
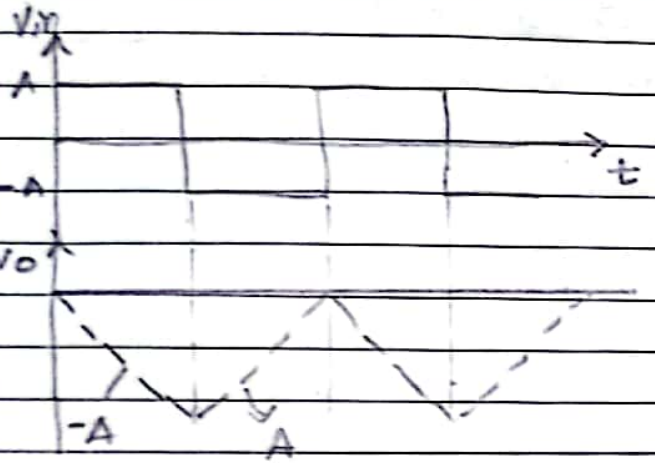


fig-ⓒ step signal

fig-ⓓ output signal

(3) Vin = square wave :-



Effect of Noise, Analog Filtering, Digital Filtering :-

Effect of Noise :- Noise refers to unwanted or random signals that can interfere with the desired signal. In signal conditioning, noise can degrade the quality of the signal and make it more difficult to extract useful information. It can be arise from various sources, such as electromagnetic interference, thermal noise or limitation of electronic components.

omitted

The effect of noise through the Filter Techniques. Filter helps to reduced the impact of noise on the signal and improve its quality for further processing.

Analog Filter :-

Analog filter involves the use of analog ckt. such as, Resistor, inductor and capacitor to modify the characteristics of the signal. Analog filters are commonly used in signal conditioning to attenuate unwanted frequicies, remove noise, or sharp the freq. response of the signal.

Analog filter can be designed as low-pass, high-pass, Band-pass or Band-reject filter to selectively allow or block certain freq. components of the signal. The undesired freq. components, including noise, can be attenuated, improving the quality for subsequent processing stage.

Digital Filtering :-

Digital filtering involves processing the signal in the digital domain using digital signal processing techniques.

Digital filter are implemented through algorithums and computation performed by micro-processor, digital processor or dedicated hardware.

Advantage of digital Filter in signal conditioning :-

1. They provide Flexibility in terms of filter char^n and can easily modified.
2. Digital filters can implement a wide range of Filter types, including Finite impulse response Filter and Infinite impulse response filter.
3. Digital filtering allows precise control over filter parameters. such as cutoff frequencies, stop band attenuation and filter order.
4. It enable efficient noise removal signal enhancement and freq. response shaping.

Overall noise, analog Filtering and digital Filterning all contribute to signal conditioning by reducing noise, improving signal quality and shaping the Freq. response as need.

Data Acquisition System :-

Data Acquisition system [DAS] :- Data acquisition system may be defined as a system used for data processing, data conversion, data transmission and data storage. In otherwords, A data acquisition system is an information system that collect, stores and distributes. of information. It is used in industrial and commercial electronics and environmental and scientific equipment to capacture the electrical signals or environmental condition on a computer device. A data acquisition system is also known as a data Logger.

These data acquisition system will perform the tasks such as conversion of data, storage of data, Transmission of data processing of data For the purpose of monitoring, analyzing or controlling the system and processes.

Data acquisition systems instrument are the combination of a number of data acquisition components which make complet system or self-contained instruments.

Types of Data Acquisition sytems:

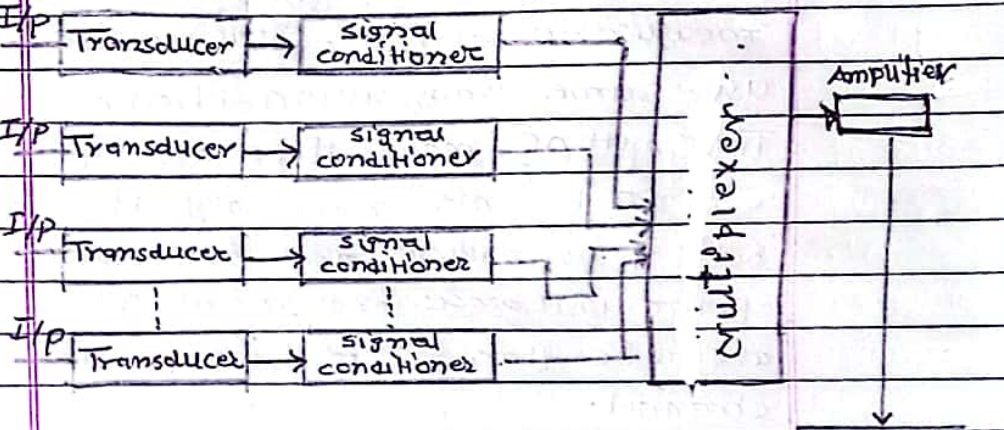
Data acquisition system is measurement systems by which data is acquired economically and efficiently in desired Form.

Data acquisition system can classified into Two types which is given belows.

1. Analog Data Acquisition system.
2. Digital Data Acquisition system.
3. Analog Data Acquisition system:-

The data acquisition systems, which can be operated with analog signal are known as Analog data acquisition system.

1. Transducer :-
2. signal conditioner :-
3. Multiplexer :-
4. Amplifier :-
5. Analog Data :-



[fig-① Analog data acquisition system]

1. Transducer :- It convert the physical quantities into electrical signals. one form of energy to another Form of energy. ie Non Electrical signal to Electrical signals, such as voltage or current.
2. signal conditioner :- It takes output From the transducer and make its into suitable form of condition and desired signal ... sending to multiplexer.
3. Multiplexer :- multiplexer is the process of showing single channel with more than one input and multiplexer accept

multiple analog input and connects the sequentially to one measuring output. Multiplexing use same Transmission channel for Transmitting more than one quantity. it becomes necessary if distance betⁿ transmitting and receiving point is large and many quantities are to be transmitted by seperate channel.

④ Amplifier :- An amplifier is increase the power of signal or Amplifier is increases the amplitude of the signal an input teminals than output teminals greater produces the amplitude signal. in output teminals. An amplifier ckt is power gain is greater than one.

⑤ Analog Recorder/ -Device :- It displays the input signal for monitoring purpose.

⑥ display :- Display the input analog data.

⑦ Meter :- Reads the anlog - input value.

⑧ Recorder :- Recorder records the input analog data per-manently.

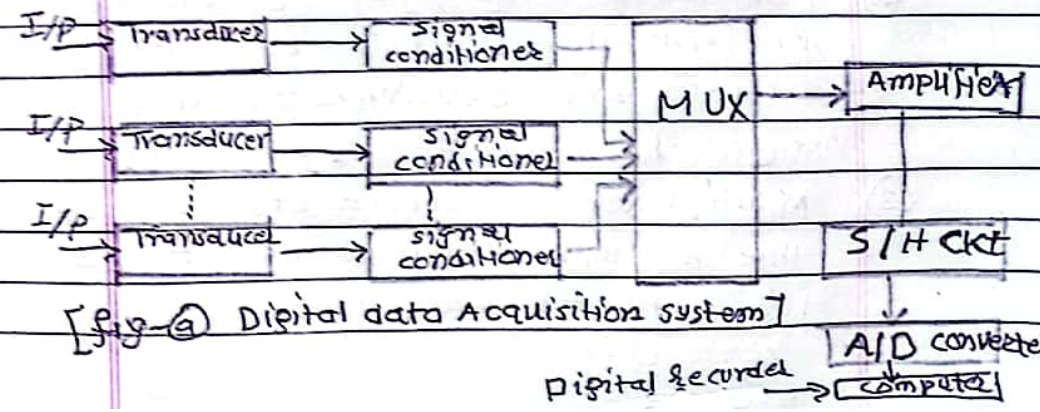
② Digital Data Acquisition System :-

The data Acquisition systems, which can be operated with digital signals are known as digital data Acquisition system. so that they use digital compon-ents for storing or displaying the informations.

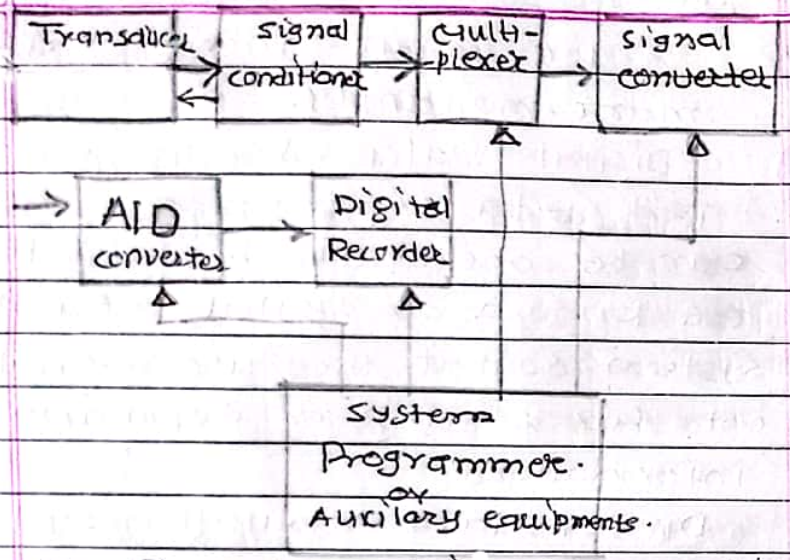
Digital data Acquisition system [DAS]

components :-

① Transducer :-
② signal conditioner :-
③ Multiplexer :-
④ Sample and Hold CKT :-
⑤ A/D converter :-
⑥ Digital Recorder/ computer :-



[Fig-① Digital data Acquisition system]



[fig ⑥ Modern Digital data Acquisition system]

① Transducer :- It is converted Non-electrical quantities [signal] to Electrical signals or it can say physical quantities to electrical signal.

② signal conditioner :- It is perform the function like amplification and selection of desired signal.

③ Multiplexer :- connects one of the multiple input to output so it's acts as parallel to serial converter.

④ Sample and Hold CKt [S/H CKt] :- It is usually used with an analog to Digital converter to sample the input analog signal and hold the sampled signal, hence the name "sample and hold". In the sample and hold ckt, the analog signal is sampled For short interval of time. [10 us to 1 us range]. After this, the sampled value is hold until the arrival of next input signal to be sampled. The duration of holding the sample will be usually milliseconds to Few seconds. The sampled value when provided to the ADC, it generates a discrete signal From an analog signal.

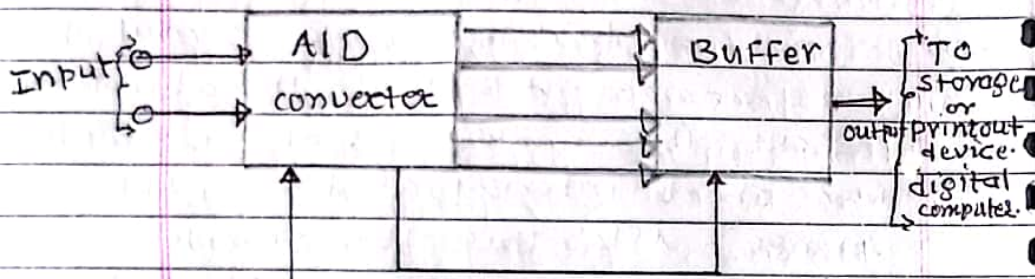
⑤ A/D converters :- It converts to analog input to Digital outputs.

⑥ Digital Recorder/computers :- It is used to record the data in digital format.

③ Single channel data acquisition system :-

The system consists of a "signal conditioner" followed by an analog to Digital converter [A/D]

performing repetitive conversions at a free running, internally determined rate.

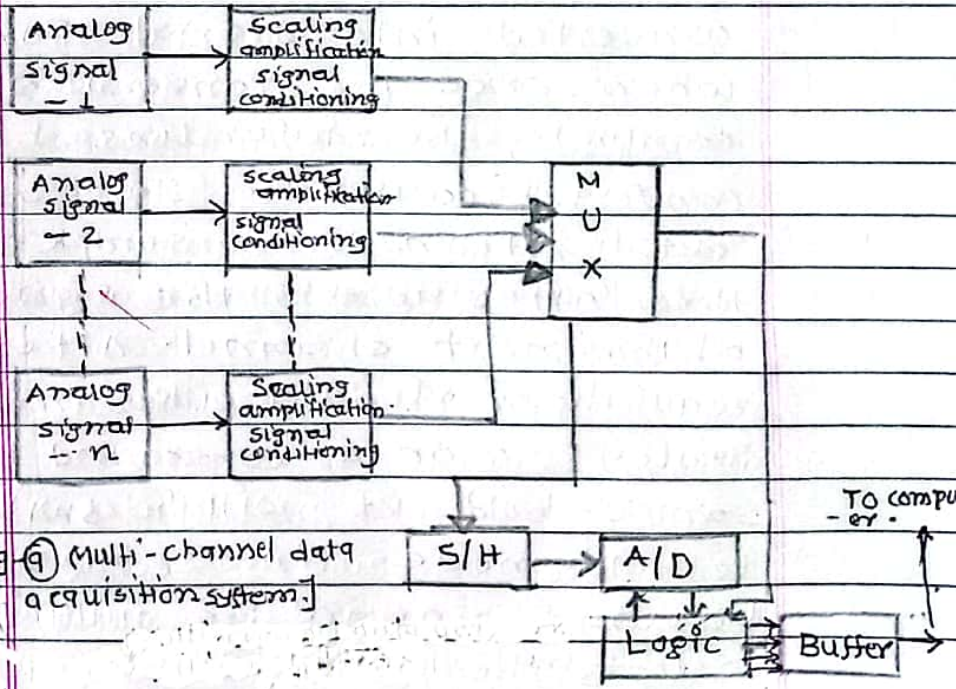


[fig-⑧ single channel data-acquisition system]

The digital outputs from the buffer are further fed to a storage or printout device or to a digital computer for analysis. Ex- Digital panel Meter [DPM]. A/D converter on the based on dual slope conversion techniques, useful for Low freq. data. Successive approximation type A/D converter also have High resolution and high speed. For signal level which are Low compared to input requirements, amplification may be used in order to bring up the level of the input. Amplification is done by Amplifiers by single ended input or differential Input.

④ Multi-channel data acquisition system:

There will be many sub-system in a data acquisition system can be time-shared by two or more input sources. Based on the derived properties of the multiplexed system a number of techniaue are employed for such time-shared measurements.



[fig-⑨ Multi-channel data acquisition system.]

The output of Transducer given to signal conditioning ckt and From output of signal condition-ing ckt signal goes to multiplexer The multiplexer output is convet-ted into digital signals by A/D converter sequentially. The multiplexer stores data say of the first channel in the sample hold ckts. It is then seeks the second channel. During the interval the data of the first channel will be converted into digital form. when once the conversion is complete, the status line from converter causes the sample-hold ckt return to the sample-mode. then after accepts the signal of the next channel. After acquisition of data either immed-italey or on a command the sample-hold ckt will be switched to hold-mode. Now conversion begins and the multiplexer selects the next channel.

This method is slow, sample hold ckts or A/D converters are multiplexed For faster operations. This method less costly.

(5) PC Based Data Acquisition System:-

The most visible trends can be seen as the effects of Transition to PC-base DAS [Data Acquisition System] Now, all that processing is being done inside computers, so instrum-ents are interfaced to a computer with analysis being done through computer software. Thus we see a more software-defined approach to DAS, as well as the emergence of high-speed USB [universal serials Bus] enabled Data Acquisition system.

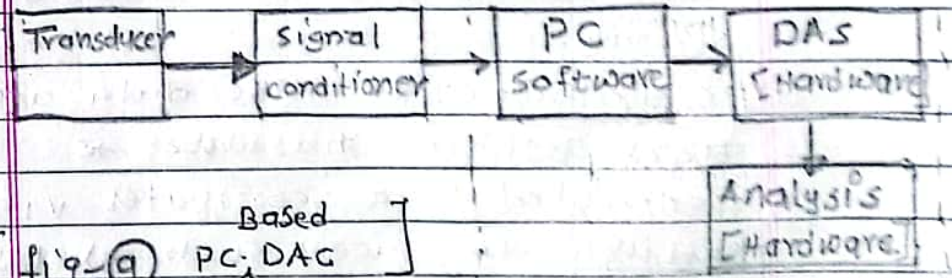


fig-(a) PC Based DAC

Data acquisition Hardware :-

The data acquisition hardware serves as the interface between physical signals and the computer. It is typically consists of analog to digital converters [ADC] for converting analog signals to Digital data. Digital-to-analog converters [DAC] For converting digital Data into analog signals. The various I/p or o/p channels For handling diffrent types of signals [analog, Digital, counter/timer etc].

The hardware may also include signal conditioning components like amplifier, filter and isolation ckts to enhance the quality and reliability of the acquired signals.

PC Interface :- The data acquisition system hardware is connected to a computer via a suitable interface, such as USB PCIe [peripheral component interconnect Express] Ethernet or wireless connections. The interface enables the Transfer of acquired data bet^n the hardware and computer.

Drive and software :- To communicate with the data acquisition hardware, the computer device drives and appropriate software. The device drives establish necessary communication protocols and provided an interface For accessing and controlling the hardware from the software applications.

The software typically includes development tools and libraries that facilitate data acquisition, signal processing, and visualization and analysis.

Benefits of PC-Based DAS

1. Versatility :-
2. processing power :-
3. Integration :-
4. cost-Effectiveness :-

(1) **versatility :-** Ability to utilize a wide range of software and hardware option.

(2) Processing computers :- PCs provide ample computing power for real-time signal processing analysis and visualization.

(3) Integration :- P-C Based DAS system can easily integrate other software and hardware components making them suitable for complex measurement and control systems.

(4) cost-effectiveness :- It is more cost-effective.

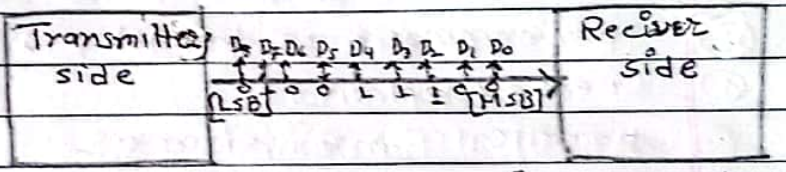
Series and parallel Transmission :

The process of sending data betⁿ two or more digital devices known as data Transmission. Data Transmitted betⁿ digital devices using two methods :-

(1) serial Transmission :- [(A) Sychronos Transmission (B) Asychronos Transmission]

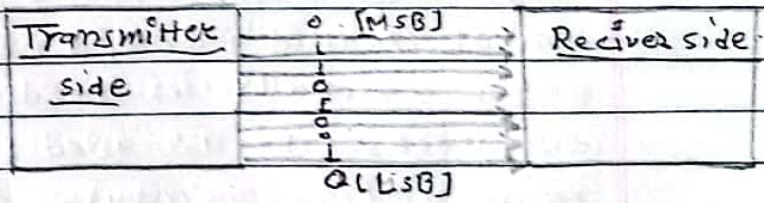
(2) parallel Transmission :-

(1) serial Transmission :- In serial Transmission, data-bit Flows Bom one computer to another computer in bi-direction. In this Transmission, one bit Flows at one-clock pulse. In series Transmi-ssion, For 8-bits aree Transfered at a-time having a start and stop it.



[Fig-(a) serial Transmission]

(2) parallel Transmission :- In parallel Transmission, many bits aree Flow togethes simultaneously From one computes to another computer. parallel Transmission is faster than serial Transmission to Transmit the bits. parallel Transmission is used for short distance.



[fig-(b) parallel Transmission]

Difference bet? serial and parallel Transmission :-

Serial Transmission :-

① Bit Transmission :- only one bit is transferred at one clock pulse.
② cost efficients :-
③ performance is Lower.
④ Less complexity.

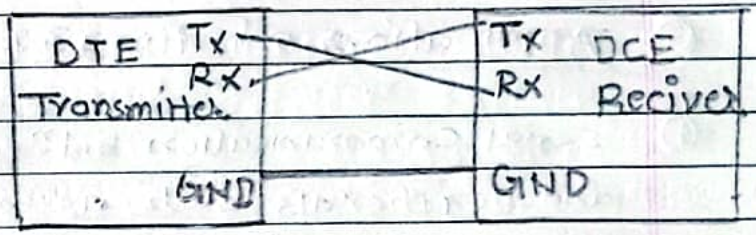
parallel Transmission :-

① Bit-Transmission :- 8-bits Transferred at one clock pulse.
② It is not cost efficients.
③ preferred only for short distance.
④ more complexity.

Features and application of Rs 232 Cable :-

RS-232 [Recommended standard -232]. It is type of serial communication used for Transmission of Data normally in medium or long distances, It is used for connecting computer and its peripheral device to allow serial data exchange bet? them. As its path data exchange bet? them. It is used to serial communication upto 50 Feet with rate of 1.49 kbps. For EIA [Electronics Industry Association] defined, The RS 232 used for comeding DTE [Data Transmission Equipment] and DCE [Data communication Equipment]

Kbps- kilo bit per second



RS-232 Features :-

① RS-232 uses Asynchronous communication so no clock is shared bet? PC and MODEM.
② Logic 0-pin is started voltage range high let assume +12 V, Logic-1 pin is started rang Low, Let assume range -12 V.
③ MAX 232 IC can installed easily to establish RS-232 interface with microcontrollers.
④ Full-duplex interface of RS-232 is very convenient.

(5) Two-pin simplex RS-232 interface can also established.

(6) A max^{m} data Transfer speed of 19 kbps is possible through RS-232.

(7) A max^{m} current of 500 mA can be drawn from pin of RS-232

Application of RS-232 :-

(1) Serial Communication bet^{n} computers and peripherals such as modems, Printers, Barcode scanners and industrial control device.

(2) conf^{n} and programming devices including routers, switches, N/W devices and embedded systems.

(3) As Data Acquisition and Instrumentation used For connecting data acquisition devices such as sensors, data Loggers and Measuring Instruments to a computer control system.

(4) Industrial Automation and control to enables communication bet^{n} Programmable logic controllers [PLCs], Human-mlc interfaces [HMIs] and other control devices.

Features and Application of IEEE 1248 B

IEEE-1248-2020 is titled "standard For Analog to Digital converter [A/D] Testing - Methods and Metrics. This std. provided guidlines and Methods for testing the Performance of A/D converters used in various applications.

Features of IEEE 1248-2020 :-

(1) A/D converters Testing Method :- The various methods for evaluating the performance of A/D converters, including the testing of accuracy, linearity, resolution, dyamic range and importants parameters.

(2) Test procedures :- It convers aspects such as test setup, test-signals, measurement techniques and data analysis.

(3) performance Metrics :- ADCs ability to convert analog signals into digital representation accurately.

④ Reporting Requirements :- IEEE 1248-2020 specifies the information that should be included in test reports to ensure clear and consistent documentation of ADC performance.

Optical communication, Fibre-optics, Electro-optic conversion Device :-

optical communication :-

Optical Fiber communication is method of communication in which signal is transmitted in the form of light and optical fiber is used as a medium of Transmitting and those light signal from one place to another place. The signal Transmitted in optical fiber is converted from electrical signal to light signal from Transmitting end to receiving end and it is converted back into the electrical signal from light. The data sent in form of audio, video or Telemetry data for long distance or Local Area N/w.

① Transmitter side :-
② Optical Fiber cable :-
③ Reciver side :-

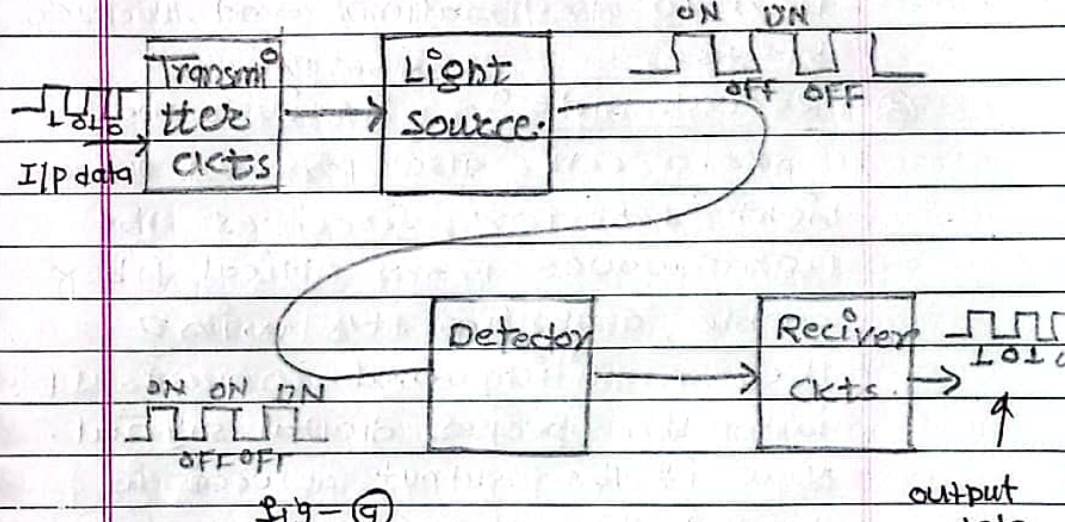


fig-④

① Transmitter side :- First if data is analog then it sent to be converter ckts which converts the analog signals into digital pulses of 0, 1, 0, 1 and passed through a Light source Transmitter ckt. If the input signal is digital then it is directly sent to the Light source ckt.

which converts the signal in the form of light wave.

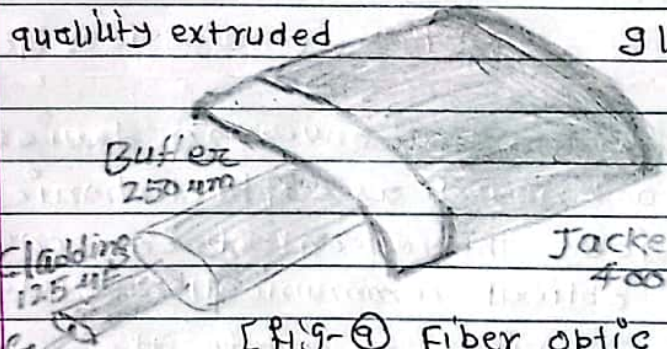
② Optical Fiber cable :- The light wave received from the Transmitter ckt to the fiber optic cable is now Transmitted from source location to destination and reciver blocks.

③ Reciver side :- Reciver side photo cell, also known as Light detector, receives the light waves from optical fiber cable, amplifies it's using the amplifier and converts it's into the proper digital signal. Now if the output source is digital then the signal is not changed. If the output source need analog signal then the digital pulses are converted into analog signal by using converter or decoder ckt.

The whole process of Transmitting an electrical signal from one point to other by converting it's into light using Fiber optic cable as Transmission source is called optical-Fiber-communication.

Fiber Optics :-

Fiber-optice involves Transmission of light signals through optical fibers, which are typically made of glass or plastic. This fibers have the ability to guide light through multiple reflections, allowing for efficient and high-speed Transmission of data over long distances. The diameter of Fiber optic cable is made of high-quality extruded glass [Si] or platic and it is flexible.



[Fig-① Fiber optic cable]

The diameter of fibres optic cable is in bet^n 0.25 mm to 0.5 mm [: sightly thicker than a human hair]

Fiber optics :-

1. Low loss :- Data to be transmitted over long distance without significant degradation.
2. Large Transmission capacity.
3. Easy Amplification.
4. High Bandwidth allowing for Transmission of large amounts of data simultaneously.
5. Immunity to Electromagnetic interference - suitable use in environments with high elerical noise.
6. Light-weight and Flexible :- make easy to install and for various applications.

Electro-optic conversion devices :-

Electro-optic conversion devices, also known as opto-electronics devices. The essential components in optical communication systems. This devices facilitate the conversion of electrical signals to optical signals and vice-versa.

some commonly used electro-optic conversions devices include :-

1. LEDs [Light emitting Diodes] :- LEDs are used as light sources in optical communication systems. They convert eletrical signal to light -signals. [infrared or visible spectrum]
2. Laser Diodes :- Laser diodes are another type of light source used in optical communication. They produced coherent & highly focused light, making them suitable for Long-distance Transmission.
3. photo-diodes :- photo-diodes are used to convert optical signal back into Electrical signals. They detect and convert light intensity vari-ations into electrical current, allo-wing for signal detection and processing.
4. Modulators :- Modulators are device that modulate the intensity phase or frequency of optical signal in response to an electrical signal.

These electro-optic conversion device enable the Transmission, reception

and processing of data in optical communication systems. They are integrated into Transmitter, Recivers and other system components to ensure efficient and reliable communication. Overall, fiber optic and electro-optic conversion device are crucial components in optical communication systems. High-speed, Long-distance and secure data Transmission in various applications.

Ey Upendra Yadav
[Pokhara University]

Unit-V [8 hrs]

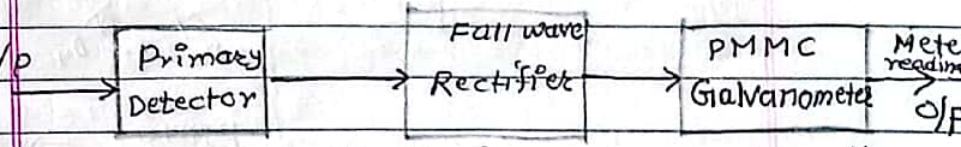
Wave Analyzers and Digital Instrumen

Wave Analyzer:- A wave analyzer is an instruments designed to measure the relative amplitude of signal-frequency components in a complex or distorted waveform. They provided a graphical representation of signal amplitudes versus Frequency, known as a spectrum. It is also called signal analyzer.

Basic-wave Analyzer:-

The Basic-wave analyzer mainly consists of three blocks

(a) Primary detector:-
(b) Full-wave rectifier:-
(c) PMMC Galvanometer:-



[fig-(a) Basic-wave analyzer]

(a) **primary detector:-** It is consists of an LC ckt, we can adjust the value of L [inductor] and C [capacitor] in such way that it allows only the

desired harmonic frequency component that is to be measured.

(b) Full-wave rectifiers :- It is converted Ac input into D.C output.

(c) PMMC Galvanometers :- It shows the peak value of signal which is obtained at the output of Full-wave rectifier.

Now, the corresponding components of above block-diagram, is the basic wave analyzer. so the ckt diagram of basic wave analyzer will shown below.

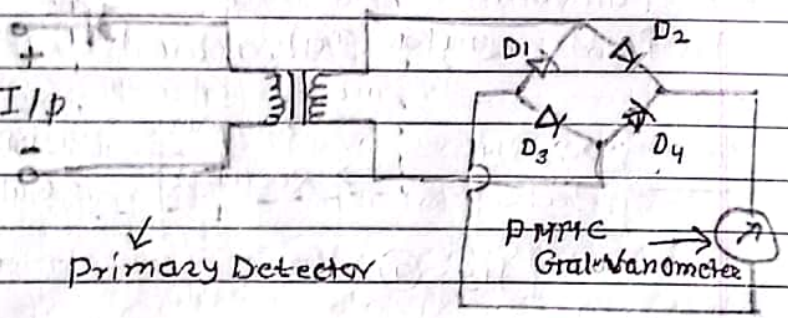


fig - (a)

This basic wave analyzer can be used for analyzing each and Every harmonic frequency components of periodic signal.

Types of wave analyzers :-

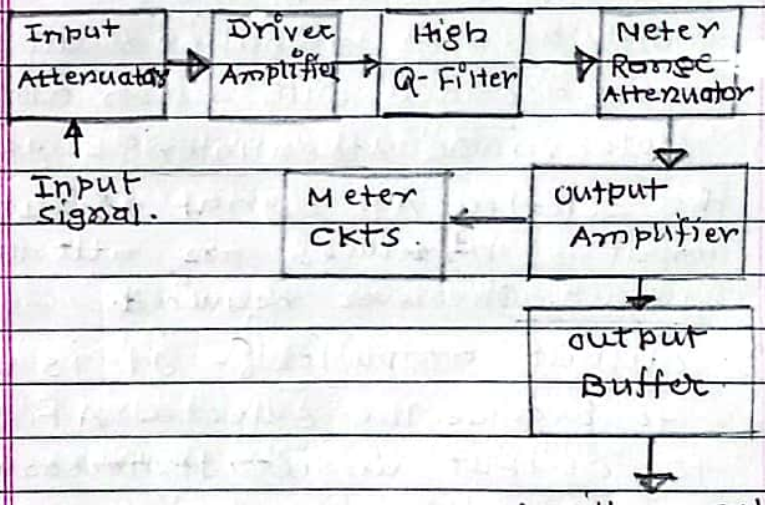
There are two types of wave analyzers, which are given below.

(1) Frequency selective wave-analyzer :-

(2) Heterodyne wave analyzer :-
[Sub:- Heterodyne wave analyzer]

(1) Frequency selective wave analyzer :-

The wave analyzer, used For analyzing the signals are of 20 Hz to 20 KHz Audible Frequency range



[fig - (a) Freq. selective wave analyzer]

① Input Attenutor :- The AF signal, which is to be analyzed is applied to input attenutor. If signal amplitude is too Large than it can be attenurated by Input attenuator.

② Driver Amplifier :- It's amplifies the recived signal when it's necessary.

③ High-Q-Filter :- It is used to select the desired frequency and rejected unwanted frequcies. It is consists of two RC sections and two filter amplifier & all this are cascaded with each other

④ Meterange Attenuator :- It gets the selected AF signal as an input & produces an attenuated output, whenever required.

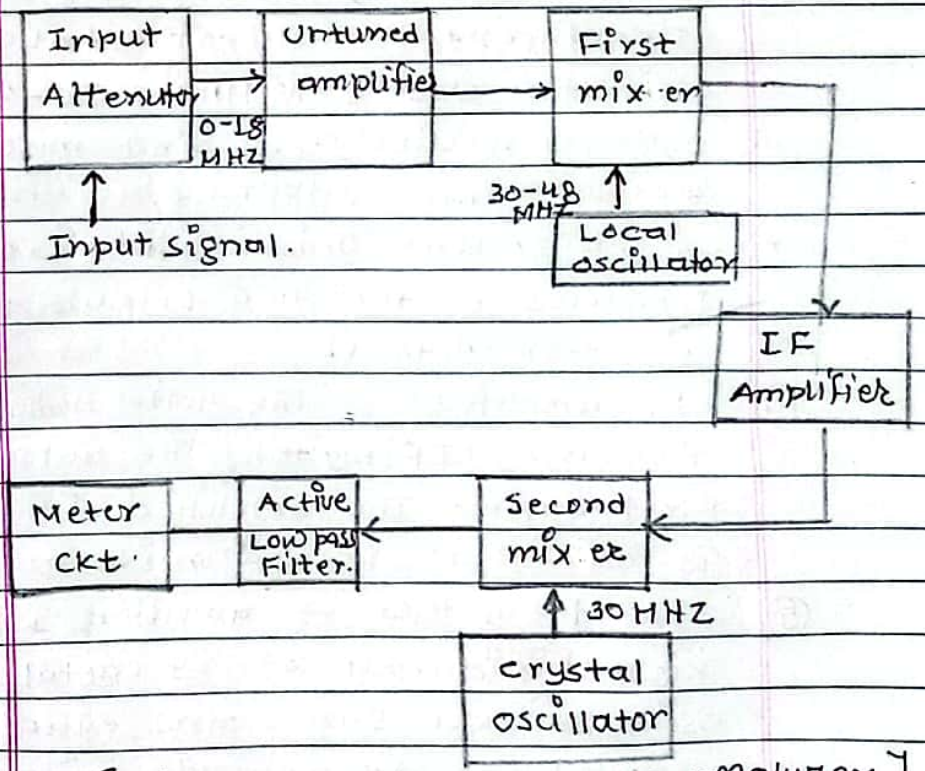
⑤ output amplifier :- It is used to provide the selected AF signal to ... If necessary.

⑥ output Butter :- It is used to provided the selected AF signal to output device.

⑦ Meter ckts :- It is displays the reading of selected AF signal. We can choose the meter reading in volt range or decible range.

② Heterodyne wave analyzer :-

The wave analyzer, used to analyze the signals of RF range is called Superheterodyne wave analyzer or heterodyne wave analyzer.



[fig-⑨ Heterodyne wave analyzer]

working of heterodyne wave analyzer :-

① The RF signal, which is given to input attenuator. If the signal amplitude is too Large, then it can be attenuated by input attenuator.

② Untuned amplifier :- Amplifies the RF signal whenever necessary It's applied to first mixer.

③ The frequency ranges of RF signal, and the output of Local oscillator are 0-18 MHz & 30-48 MHz respectively. So First mixer produces an output which has frequency of 30 MHz. This is difference of freqeucies of the two signals that are applied to it.

④ IF amplifier :- The intermediate Frequency [IF] signal, The output of First mixer. The amplified IF signal is applied to second mixer.

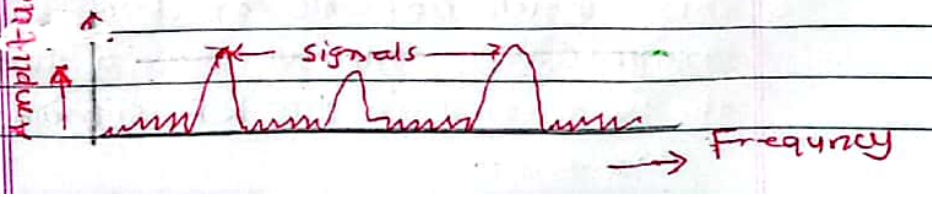
⑤ The frequencies of amplified IF signal and output of Crystal Oscillator are same and equal to 30 MHZ. So the second mixer produced an output which the Frequency is 0 MHZ. This is difference of frequencies of two signals that are applied to it.

⑥ The cut off frequency of active Low pass Filter is choose as 1500 HZ Hence, this filter allows the output signal of second mixter.

⑦ Meter ckt display the reading of RF signal. we can choose the meter reading in volt range or decibel range.

Spectrum Analyzer :-

A spectrum analyzer is a device that measures and displays signal Amplitude as it varies by frequency within its frequency range. [Spectrum]. The frequency appears on the horizontal X-axis and the amplitud is displayed on the vertical Y-axis. It looks like an oscilloscope and in fact some devices can function as either oscilloscope or spectrum analyzer.



or

Spectrum analysis of signal.

Spectrum analysis is defined as study of energy distribution across the frequency spectrum of given electrical signal.

① study gives information about band-width, effects of different types of modulation and spurious signal generation.

② knowledge of these quantities is useful in the design and testing of radio frequency and pulse circuitry.

Spectrum Analysis

① Audio frequency analysis - [20Hz - - 20KHz.]

② Radio frequency analysis - [10MHz - - 40GHz]

** ** Spectrum analyzers are instruments which capable of portraying graphically amplitude as a function of frequency in the RF Spectrum.

Applications :-

① Measurement of attenuation.

② Measurement of FM deviation.

③ Measurement of frequency in pulse studies.

Types of Spectrum Analyzers :-

These instruments provide a display of frequency spectrum over a given frequency band. spectrum analyzers use either a parallel filter bank or swept frequency technique. So we can classified the spectrum analyzers into following two types :-

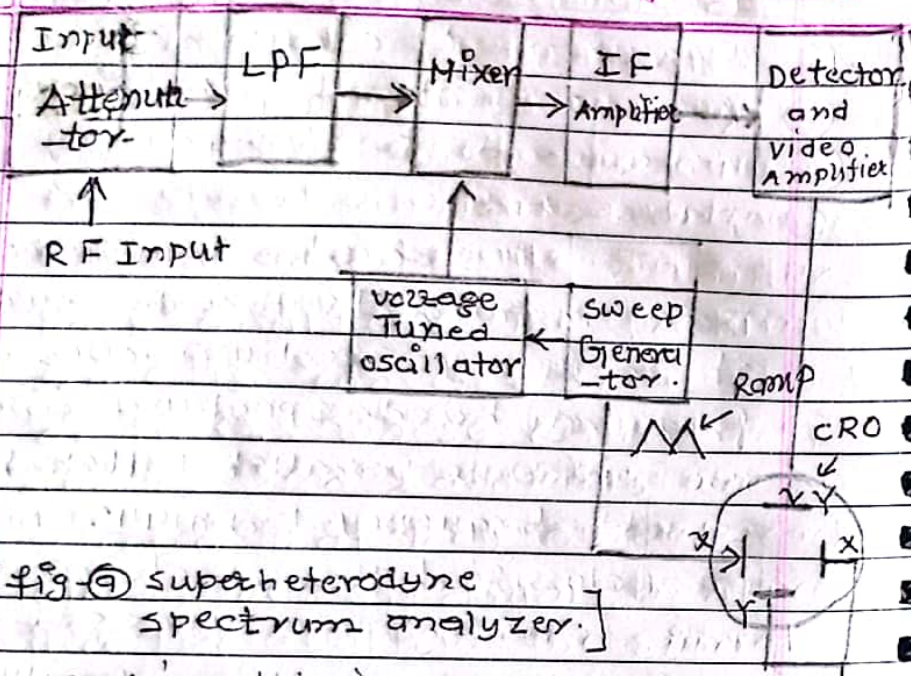
① Filter Bank spectrum Analyzers :-

② swept-tuned or superhet erodyne spectrum Analyzer :-

Basic Spectrum Analyzers using Receiver Design :-

The spectrum analyzer, used for analyzing the signals are of RF range is called superheterodyne spectrum analyzer.

The block diagram is given in fig - ④ below.



[fig ⑨ superheterodyne spectrum analyzer.]

working principles :-

① The sweep gen. or sawtooth gen. provided the sawtooth voltage which drives the horizontal elements of axis of CRO, and sawtooth voltage is freq. controlled element of the tuned oscillator. As oscillator sweeps from f_{min} to f_{max} of its freq Band at linear recurring rate. its beats with the frequency components of the input signal produced an IF.

② The RF signal, which is to be analyzed is applied to input attenuator. if the signal amplitude is too Large then it can attenuated by an input attenuator.

③ Low pass filter [LFF] :- The LPF only sending the less than the cutoff frequency

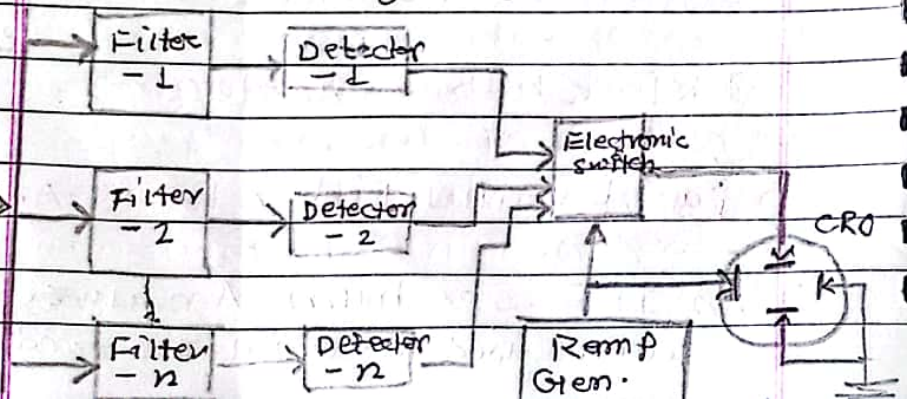
④ mixer :- Mixer get the inputs from LPF and voltage tuned oscillator and its produced output. which diffrence of frequency signals.

⑤ IF amplifier :- Amplifies, the IF signals. The output of mixer, The IF signal is applied to detector The output of detector is given to Y-axis's of CRO that means vertical deflection plat. of CRO, so that CRO displays the freq. spectrum of RF signals on its CRT screen.

IRF Spectrum Analyzer :-
or
parallel Filter Bank Analyzer :-

An IRF spectrum Analyzer is device used to analyze and display

the frequency spectrum of intermediate freq. signals. It commonly used in communication system and electronic equipments for signal analysis and troubleshooting. In parallel filter bank analyzer, The frequency range is covered by a series of filters whose central frequencies and bandwidths are so selected that they overlap each other, The spectrum analyzer, used for analyzing the signals are AF range is called filter bank spectrum analyzer or Real time spectrum analyzer because it shows any variation in all input Frequencies. The Block-diagram given below:



[Fig-① parallel Filter Bank analyzers]

working principles of parallel filter Bank analyzers :-

① It is set of Band pass filters and each one is designed for allowing a specific band of Frequencies. The output of each band pass filter given to detector.

② All the detector output are connected to the electronic switch This eledronic switch allows the detector outputs sequentially to the vertical deflection plate of CRO, so CRO displays the frequency spectrum of AF signal on its CRT screen.

Distortion Analyzer :-

Harmonic Distortion Analyzer :-

- Fundamental suppression Type :-

Fundamental suppression Types :-

Distortion analyzer measures the total harmonic power present in the test wave rather than the distortion caused by each component

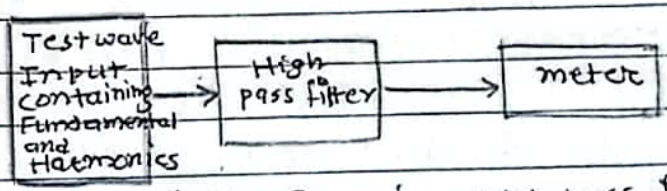
The simplest method of suppres the fundamental freq. by means of high pass filter whose cut-off freq. is a little above the Fundamental Frequency, Thus the high pass Filter allows only the harmonic-s to pass and the total harmonic distortion (THD) can measured. The most commonly used harmonic distortion analyzer based on fundamental suppression are as Followings given belows.

1. Using High pass Filter.
2. Resonance Bridge type.
3. wien's Bridge type.
4. Bridged-T Network Method

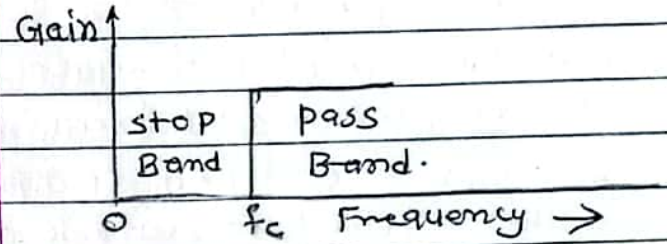
1. Using High pass Filter:-

A harmonic Distortion analyzer measured the total harmonic power present in the test wave Not distortion caused by each individual components.

The simplest method is to suppress the fundamental frequency by means of high pass filter. whose cutoff frequency, is little greater than fundamental frequency hence it falls in stop-band. This high pass filter allows the harmonics which are in pass band, hence the total harmonic distortion can measured.



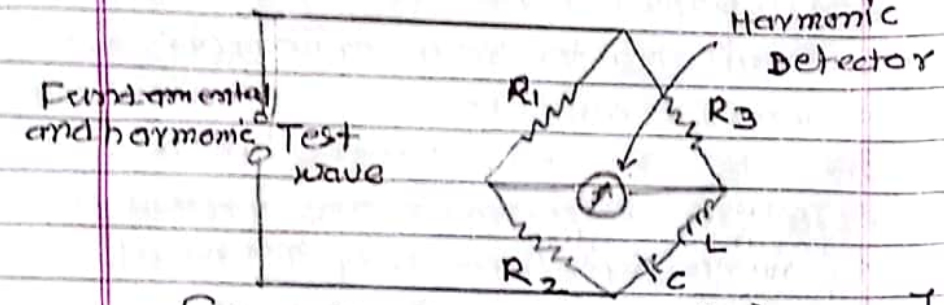
[Fig-① using High pass filter]



2. Resonance Bridge type:-

This Bridge ckt is balanced for the fundamental frequency ie L and C are tuned to the fundamental frequency. The fundamental energy is dissipated in the bridge

ckt elements. The bridge is unbalanced for the harmonics and only harmonics passed through the bridge. Hence the harmonic power is available at the output terminals and can be measured on meter.



[Fig-① Resonance Bridge ckt]

Two types measurements :-

① Fixed fundamental frequency.

② varying Fundamental frequency.

- If L and C are fixed components then this method is suitable only when the test wave has fixed frequency.
- If the fundamental frequency is changed, the bridge must be balanced again.

when a continuous adjustment of the fundamental frequency is desired a wien bridge arrangements is used.

- Indicators can be thermocouples.
- The meter indicates the r.m.s. value of all harmonics.

③ Wien's Bridge Method Type :-

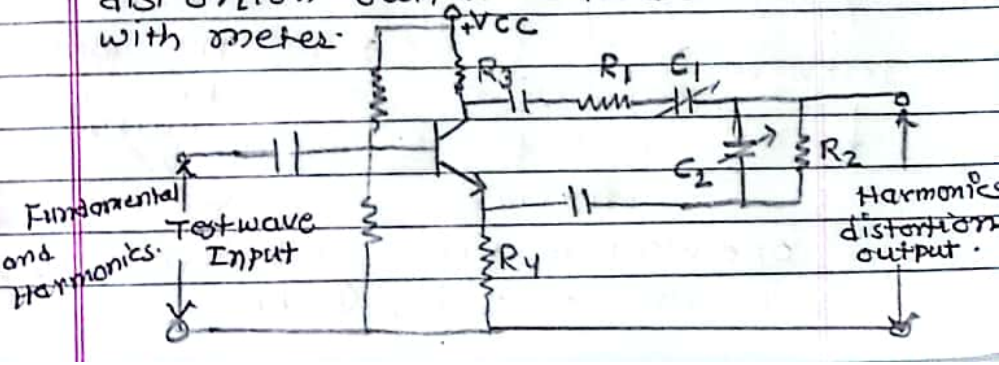
- The Bridge is balanced for Fundamental frequency. For balanced at the fundamental frequency

$$C_1 = C_2 = C$$

$$R_1 = R_2 = R$$

$$R_3 = 2R_4$$

The fundamental energy is dissipated in the bridge ckt elements. The bridge is unbalanced for the harmonic only the harmonic components reach the output terminals. The harmonic distortion output can be measured with meter.



[Fig-ⓐ wien's Bridge method]

④ Bridge T-Network Method :-

- L and C_s are turned to fundamental frequency and R is adjusted to bypass fundamental frequency. The tank ckt being tuned to the fundamental freq. the fundamental energy will By circulate in the tank and passed by the resistance. only harmonic components will reach the output terminals and the distorted output can be measured by the meter. The Q of the resonant ckt must be at least 3-5

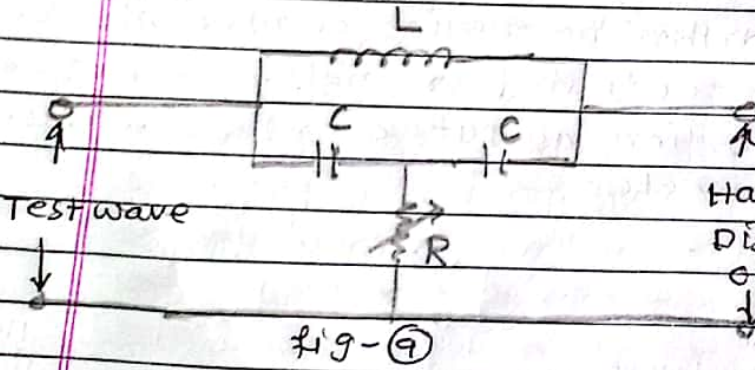


Fig-ⓐ

one way of using a bridge T-N/W is shown in fig-ⓑ below:

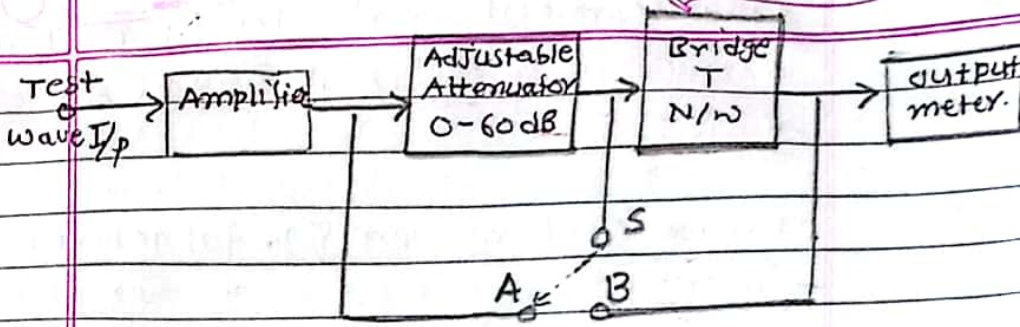


Fig ⓑ Harmonic Distortion Analyzer using Bridge T-N/W method]

The switch is first connected to point A so that the attenuator is excluded and the BridgeT-N/W is adjusted For suppression of the fundamental Frequency ie minimum output. The min^{n} output indicates that the bridge T-Network is tuned to the fundamental frequency. The switch is next connected to terminals-B. ie the Bridge T-N/W is excluded or bypassed. The Attenuation is adjusted until the same reading is obtained on the meter. The attenuator reading indicates the total r.m.s distortion.

Measurements of frequency and Time & Decimal count Assemblies :-

Measurement of Time [period Measurement] :-

In some cases it is necessary for digital measurement of Time rather than Frequency. This is espacially true in the measurement of frequency in the Low frequency range. To obtain good accuracy at Low Frequency, we should measurements of the period, rather than make direct frequency measurements. The ckt used for measuring frequency can be used for measurement of time period if the counted signal and gating signal are Interchanged. The fig-① given belows.

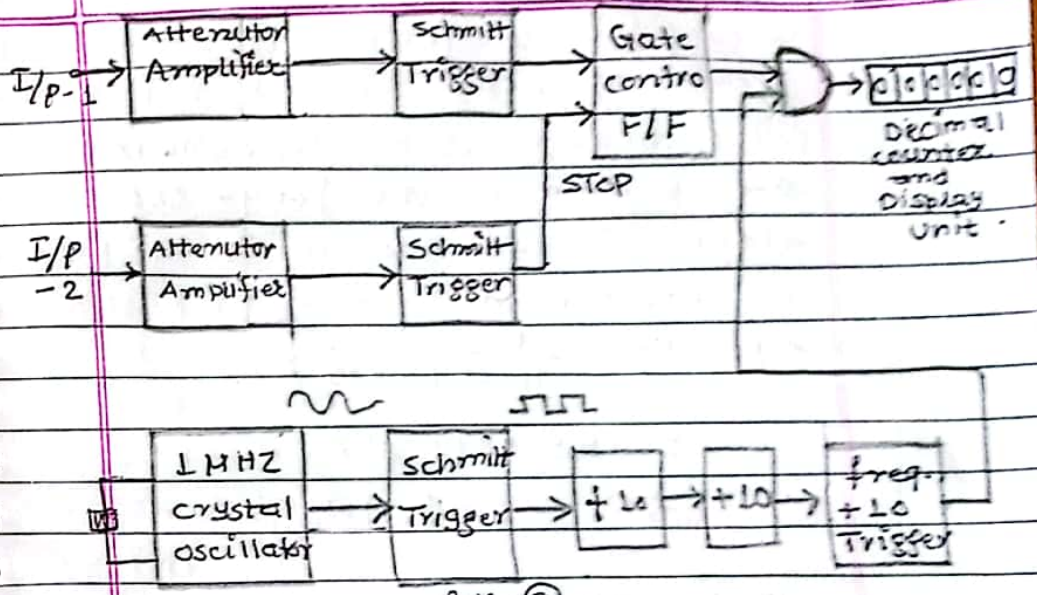


fig-②

The above fig-② shows that the ckt for digital measurements of Time period. The gating signal is derived from the unknown input signal which now controls the enabling and disabling of the main gate. The number of pulses which occure during one period of the unknown signal are counted and displayed by the decode counting assemblies. The disadvantage of this system is measuring the Low freq. range, The operation has to calculate the freq. from the

time by using eqn-

$$f = 1/T$$

For example:- when measuring the period 60Hz freq. the electronic counter might display

16.6673 ms

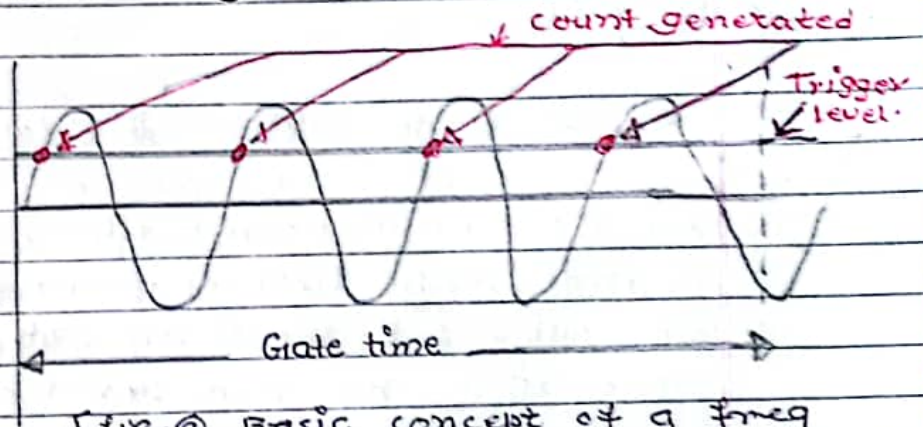
$$f = 1/T = \frac{1}{16.6673 \times 10^{-3}}$$

$$= 59.9977 \text{ Hz.}$$

Frequency Counter :-

A freq. counter is an electronic instruments used to measure freq. and Time. freq. counters are used for a wide range of freq. and time measurements and display many digits of accuracy freq. counter helps measure the time of reputed digital signals and the freq. correctly and associ-ates with wide range of radio frequencies. In otherwords, These are essential instruments that count the number of cycle per-seconds of an input signal.

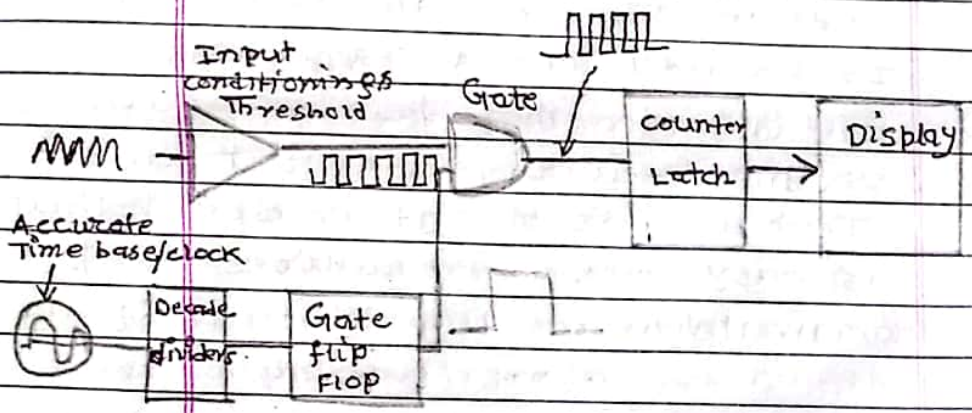
These are used in electronics and Telecommunication industries to measure freq., Bandwidth, peak-to peak voltage or current or rise time Freq. counters count the pulses and Transfers them into Freq. counter when the member of pulses or events occur in a period and display-s it on the freq. range of vib-rations. The counter then set to zero. freq. counter are often found in-built into other devices such as Radio Recivers, radar set, and Test equipments. It is devic that is easy to use, measures the freq. accurately and display it digitally.



[Fig-① Basic concept of a freq counter]

Block diagram and working :-

The freq. counter Block diagram contains input signal, input conditioning, and threshold AND gate, counter or Latch, accurate timebase or clock, decade dividers, flip-Flop and display.



[fig- ⑨ Freq. counter Block diagram]

① A Freq. counter measures a signal in the first splite into the pulse setting. It operates by counting the number of times the signal passes through the voltage point to a trigger point in a duration.

② The Trigger of freq. counters stae at zero crossing point automati - cally. It is a device that sets in a clock speed with pulse per unit cycle and the pulses present sent to the device for a limited time.

③ After this, vibration / pulses apply in a definite interval of time, counts the pulse.

④ An electric counter does the whole process and the pulses are sent to the cycle to represent the unidentified signal and give it a value.

⑤ The freq. counter works on two - modes to generate the pulses and - time delay.

⑥ Whenever we talk about the working of the freq. counter, then the pulse in this device generates from the wave gen. or microcontrollers. The timer in this device figures as a counter.

⑦ It sets the count of the pulses

From high and Low. The Final count of the pulses takes place.

⑧ The device that converts the resultant by multiplying it by ten frequency cycles per seconds converts the value of the pulses in HZ. After the whole calculation inside the freq. counter, The freq. of the pulses becomes visible on the LCD or LED.

Types of Frequency counter :-

① Bench Freq. counter :-
② PXI Freq. Counter :-
③ Handheld Freq. counter :-
④ panel Meter :-

① **Bench freq. counter :-**
Bench freq counter is a type of device that useful in appling electronic test equipment. It measure the period and equal freq. precisely. This device is also known as For reducing measurement error due to temp drift.

This device used in electronic Lab and Electronic project, For measuring freq of a periodic signals.

② **PIX freq. counter :-**
PXI freq. counter is helpful in the control system and track system for tests. It is measuring the freq. and phase of an input signal as per ref^{n} signal. It application is mainly in audio, video, and RF signal. For different application of the device is testing microwave ckt, wireless devices and Antennas.

③ **Handheld freq. counter :-**
A handheld freq. counter helps Measure the freq. of cycles per seconds of a periodic waveform in the signal. It provides precise measurement of output Application of this device to measures the radio-frequencies.

④ **panel Meter :-** A panel meter is type of freq. counter available in panal mount mode. It applications in determining the freq. of audio and radio - signals.

Error :-

Counter Error and signal Related Error :-

① A counter error typically indicates a problem or discrepancy in the freq. or time measurement performed by the wave analyzer's counter. The counter is responsible for counting the number of cycles or events within a given time period.

② A counter error might occur if there are issues with the counter circuitry, calibration or if the signal being measured is outside the counter's measurements range. In such cases, the accuracy and reliability of the freq. or time measurement may be compromised.

③ A signal-related error generally refer to an error or issue related to the input signal being analyzed by the wave analyzer. This include various factors, such as noise, distortion, interference or improper signal conditioning. signal related errors can affect the accuracy of measurements and distort the waveform being analyzed and leading to incorrect or unreliable results.

Digital voltmeter :-

Digital voltmeter displays the voltage reading of a circuit numerically which used to measure the electrical p.d b/n two points in the ckt. The block diagram of digital voltmeter given below:

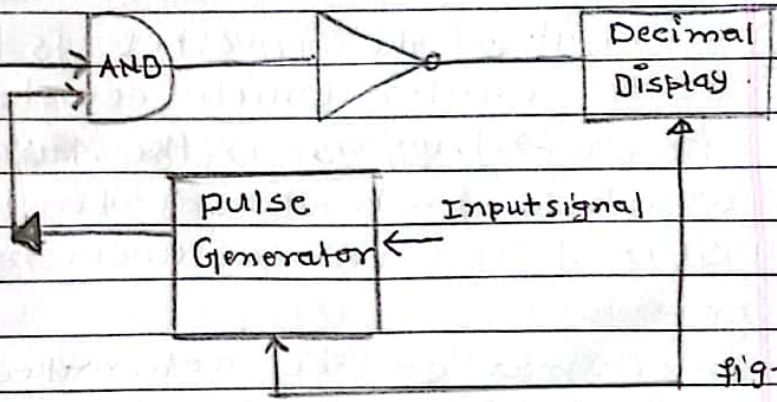


fig-④

Working principle of DVM :-

① unknown voltage signal is fed to

the pulse gen. which generates a pulse whose width proportional to the input signals.

② output of pulse gen. is Fed to one-Leg of the AND gate.

③ The input signal to other Leg of the gate is a train of pulse.

④ output of AND gate is positive triggered train of duration same -as the width of the pulse generated by the pulse generater.

⑤ This positive Triggered train is Fed to the inverter which converts it into a negative triggered train.

⑥ output of the inverter is fed to a counter which counts the no's of triggers in the duration which is proportional to the input signal ie voltage under measurements.

⑦ counter can be calibrated to indicate the voltage (V) directly.

The working of digital voltmeter that it is nothings but analog to digital converter which converts analog -signal into a train of pulses.

The digital voltmeter to A|D conversion methods.

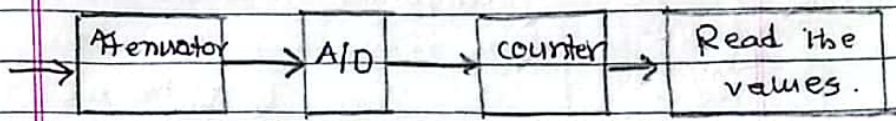


Fig-⑨

Digital voltmeters can be classified into following methods which are given belows:-

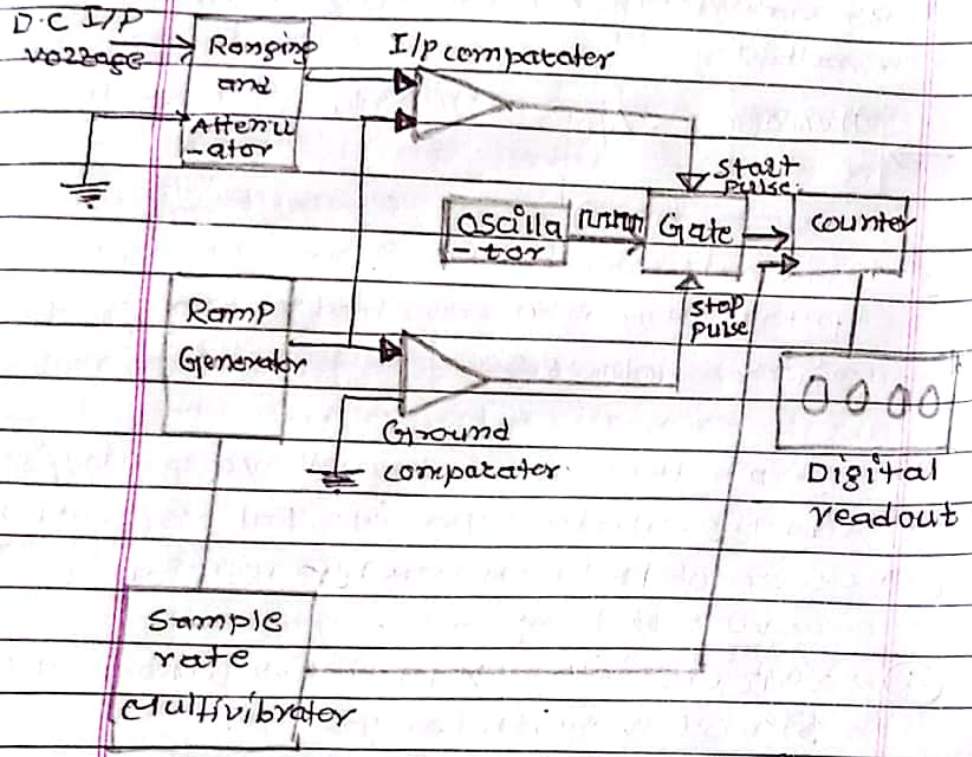
① Ramp type digital voltmeter:-
② Integrating type digital voltmeter:-
③ Servo potentiometer type digital voltmeter:-
④ Successive Approximation type Digital voltmeter:-

① Ramp type digital voltmeter:-

The Ramp type DVM, the operation basically depends on the measurements of time. The time which the ramp voltage takes to change from the level of the

Input voltage to that 0 (zero) voltage or vice-versa.

The Block diagram and operating principle of a ramp-type DVM :-



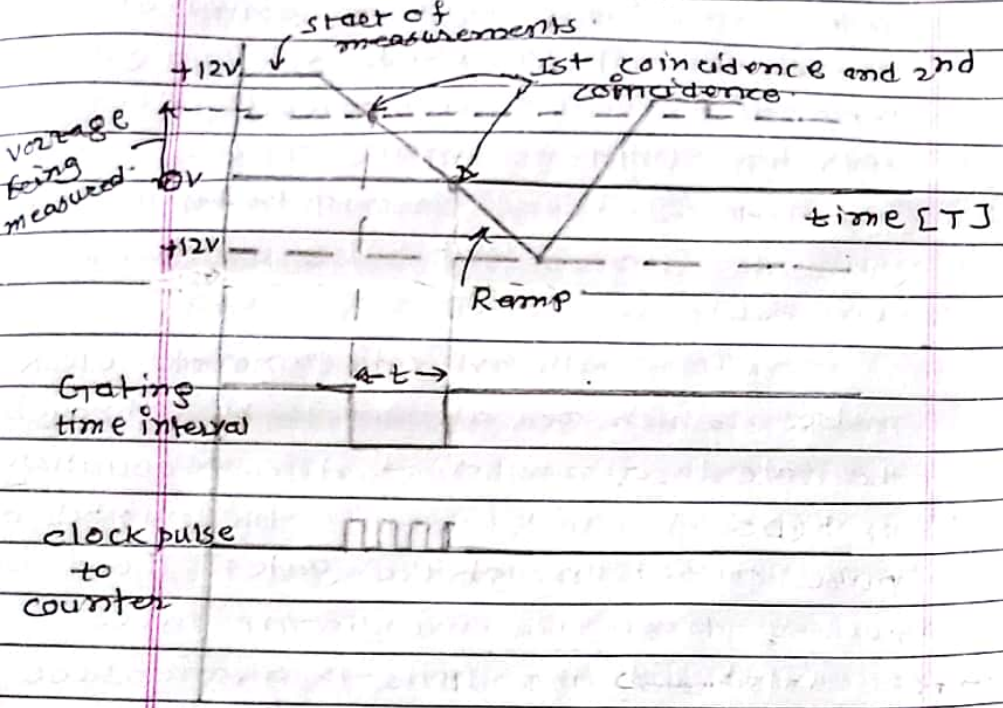
[fig-(a) Ramp-type DVM].

It shows the "voltage-to-time" conversion using gated clock pulses. At starting of cycle, a ramp voltage is initiated; this voltage positive going to, negative going. The negative going ramp continuously compared with unknown input voltage. At the instant that ramp voltage equals the unknown voltage, a coincidence ckt or comparator, generates a pulse which opens a gate. the ramp voltage continues to decrease with time until it finally reaches 0 V [ground pot.] and second comparator generates an output pulse which closes the gate.

An oscillator generates clock pulses which are allowed to pass through the gate to a number of decade counting unit (DCUs). which totalise the number of pulses passed through the gate. The decimal numbers, displayed by indicator tubes associated with the DCUs is a measure of the magnitude of the input voltage.

The sample-rate multivibra-tor [MV] determine the rate at which the measurements cycle are initiated. The sample-rate ckts provided an initiating pulse for the ramp generater to start its next ramp voltage. At the same time a reset pulse is generated which return all

DCUs to their zero state, removing the display momentarily from the indicator tubes.



[fig-④ voltage to time conversion using gate clock pulse.]

② Integrating Type Digital Voltmeter :- [voltage to-freq. conversion]

This voltmeter indicates the true avg. value of the unknown voltage over a fixed measuring period. It employs an "integration technique" which uses a voltage-to-freq (V/F) conversion. The V/F converter function as a feedback control system which governs the rate of pulse generation in proportion to magnitude of the input voltage. In voltage to freq. conversion Techniaue, a train of pulses is generated. The freq of pulse depends on the voltage being measured. The these pulse are counted that appears in a definite time interval. After all, the freq. of pulses is a function of input voltage, the number of pulses is an indication of the input voltage.

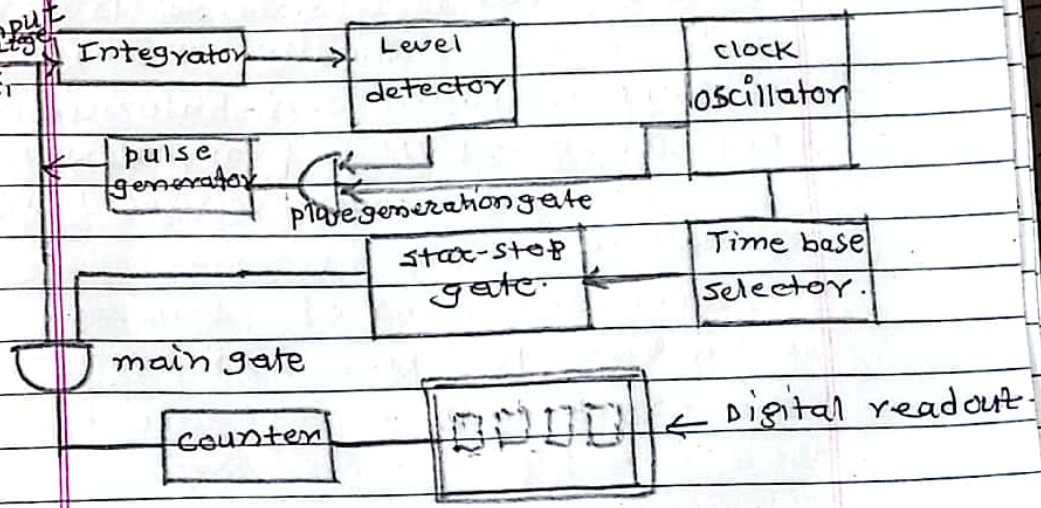
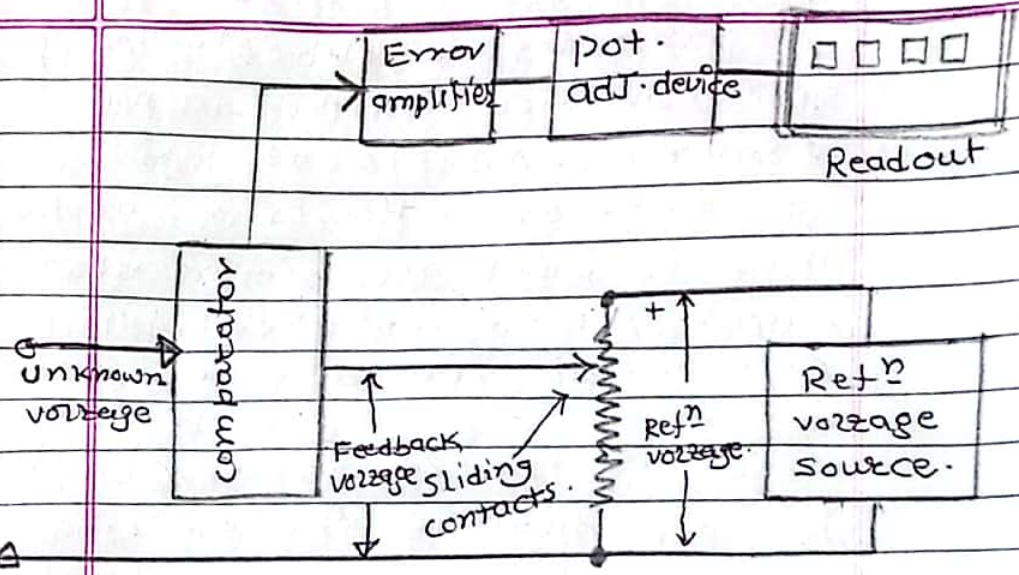


Fig ⑨ Integrating Type DVM

③ Servo potentiometer type DVM :-

A potentiometer type DVM employs voltage comparsion technique. In this DVM the unknown voltage is compared with refⁿ voltage whose value is fixed by setting of the calibrated pot. The pot. setting is changed to obtain balanced. When null conditions are obtainded the value of the unknown voltage, is indicated by the dial setting of the potentiometer. In pot. type DVM, The balanced is not obtained manualy but is arr-ived at automatically. This type of DVM is called self-balancing pot. The pot. DVM is provided with readout which displays the voltage being measured.

Block diagram of servo potentiometer type DVM is given belows.



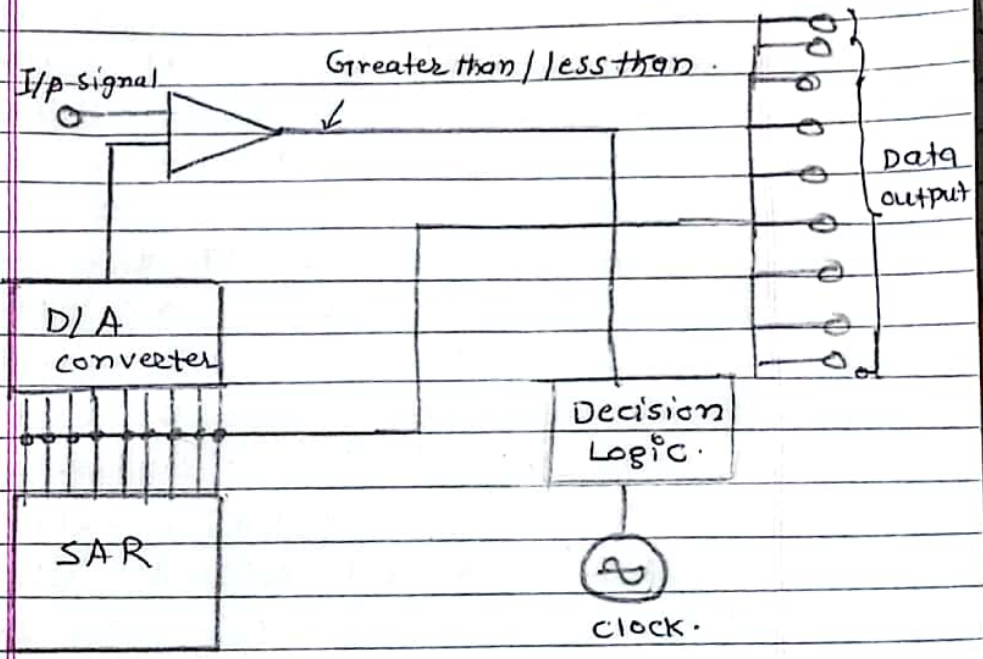
[fig-ⓐ servo. pot. type DVM]

④ Successive-Approximation Type DVM :

A digital to Analog [D/A] converter is used to provid the estimate The "equal to or greater than or less than" decision is made by the comparator. The D/A converter provides the estimate and is compared to the input signal The special shift register called a sucessive-approximation resister [SAR] is used to control the D/A

converter and consequently the estimates. At the beginning of the conversion all the outputs from the SAR are at logic zero. If estimate is greater than the input, The comparator output is high and the first SAR output reverse state and second output changes logic 'one', if the comparater output is low, indicating that the estimate is lower than the input signal the first - output remain in the logic one state and second output assumes the logic one state. This continues to all the states until the conversion is complete.

The above sequence of events are performed electronically. For an N- bit conversion after N- clocks, the actual value of the input is known. The least significant bit is the state of the comperator. In some - system an additional clock is employed to store the last bit in SAR and thus N+1 clocks are required for a conversion.



[fig-⑨ successive-approximation DVM]

Vector voltmeter:- A veter voltmeter is specialized instruments used for measuring complex voltage quantities particularly in RF [Radio frequency] and

and microwave systems.
It is designed to measure both the magnitude and phase of complex vozzage or vector quantity. like a std. vozzmeter that measures only the amplitude of vozzage signal, a vector vozzmeter provides additional information about the phase or angle of the vozzage This is particularly useful in application where the phase relationship bet" multiple vozzage signal is critical, such as in RF signal analysis. N/W analysis or impedance measurements.

The vector vozzmeter typically consists of two channels, an in-phase channel and quadrature channel. The phase channel measure the real or resistive component of vozzage.

while quadrature channel measure the Imaginary or reactive compon-ent of the vozzage.

By processing the measure-ments from both channels, the vector vozzmeter can calculate the magnitude and phase angle of complex vozzage. It can dis-play these values in various -Formates, such as polar coordinates [magnitude and angle] or rectan-gular coordinates [real or imagin-ary components].

Vector vozzmeter are commonly used in RF and micro-wave Engg for task like impedence matching, Network analysis, phase measurements and evaluating the performance of RF system.

Digital Multimeter [DMM] :-

A Digital Multimeter [DMM] is a Test tool which measure

two or more electrical components like voltage(V) current [amp] and resistance [Ω or ohm]. It is std. tool For Electrical and Electronic measurement system.

Digital multimeter combine the testing capability of single-task meters- The voltage (V) measure for volts, ammeter (amp) and ohmmeter [ohms] Advanced options also available in DMM.

DMM include components:-

1. Display:-
2. Buttons:-
3. Dial [Rotary switch]:-
4. Input Jacks:-

1. Display:- Readout the value.
2. Buttons:- selects the various functions.
3. Dial [Rotary switch]:- For selecting primary measurement values [volts, amps, ohms].
4. Input Jacks:- where the test leads are inserted. Two leads [one For Red [positive] other For Black [Negative] that plug into the DMM. The Probe tips on each lead are used for testing ckt.

Computer Based Digital Instruments

IEEE-488 GPIB Instruments:-

Now a days automatic test equipments is one of the leading method for testing electronic equipments in factory production and troubleshooting situations. The basic method is to be use a programmable digital computer to control a bank of test instruments. The bank of instruments can be configured for a purpose or for general use.

The IEEE-488 bus or General purpose interface bus [GPIB] is a tool that is based on the

IEEE [Institution of Electrical and Electronics Engineers] specification.

The digital signals on IEEE-488 bus are generally similar to TTL [Transistor-Transistor Logic] ic logic. Low is less than 0.8 V and logic High is greater than 2.0 V.

The digital signal can be connected to the instruments through a multiconductor cable upto 20 meters is length provided that an instruments load is placed every 2-meter.

Most IEEE-488 bus/GPIB system operate unrestricted to 250 bilobytes per seconds or faster with some restrictions.

There are two basic configuration for the IEEE-488/GPIB system.

① Linear :-
② star :-

① Linear :- In this type of configurations a tap-OFF to next instruments is taken from the previous one in series.

② star :- In this case, the instruments are connected from a central point.

The Basic structure of IEEE-488/GPIB system. The figure indicates the following four different devices

① computer
② Frequency counter
③ signal generator
④ Digital multimeter

The IEEE-488/GPIB system itself consists of three major buses :-

① General Interface Management [GIM] bus :- This bus co-ordinates the whole system and ensures an orderly flow of data over data I/P/O/P [DIO] bus.

② Data I/O [DIO] bus :- This bus

is a bi-directional 8-bit data bus that carries data interface message and device-dependent message betn the controllers, talkers and listeners. This bus sends asynchronously in byte-serial format.

(3) Data Byte Transfer [DBT] bus :- This bus controls the sending of data along the DIO bus.

- The signal defined for above three buses are implemented as conductors in a system interface cable.
- Each IEEE-488/GPIB system [ie computer, freq-counter, signal generater and digital multimeter] are categorised as

(1) controller :-
(2) Listener :-
(3) Talker :-

(1) controller :- It is function is to communicate device addresses and other interface buses to instruments in the system.

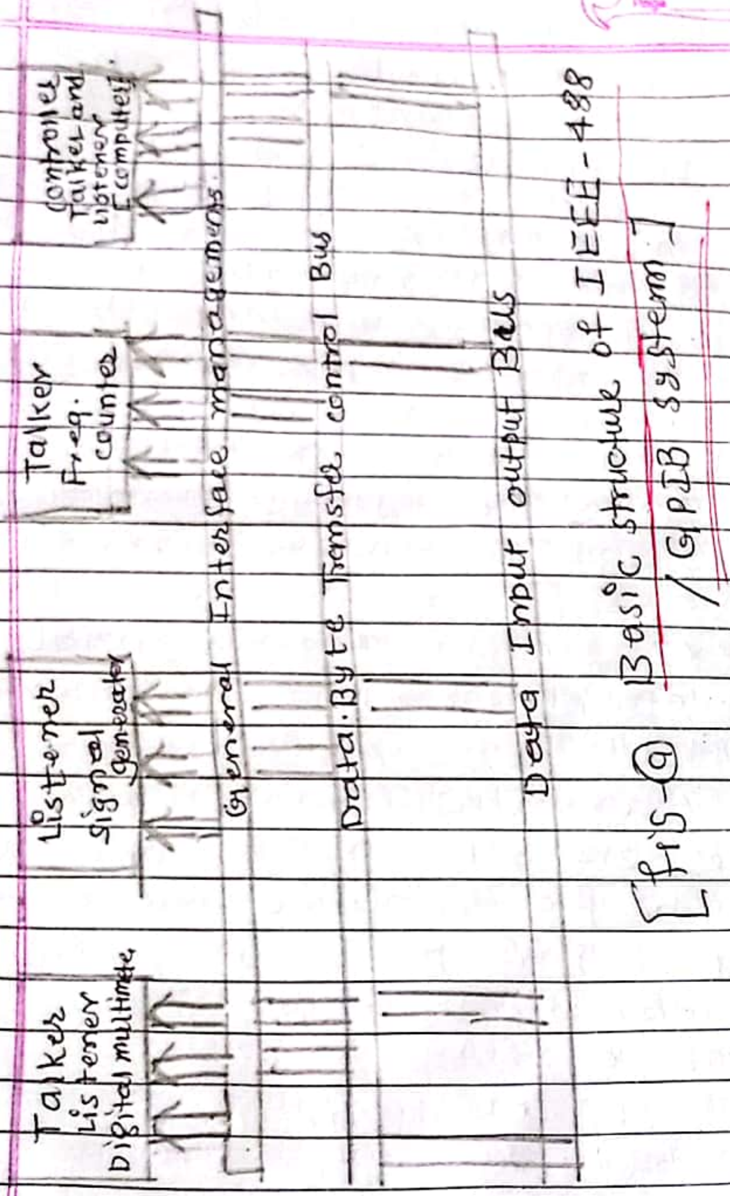
(2) Listener :- It is function to receive commands from the other instruments [usually the controller] when the correct address is placed on the base. The listener acts on the message received but does not sent back any data to the controller.

(3) Talker :- It is function to respond to the message sent to it by the controller.

- VXI bus is another widly growing platform for instrumentation system.

The VXI back plane include the 32-bit VME data bus high performence instrumentation buses for precision timing and synchronisation betn instrument components.

Block diagram is given below :-



[Fig-(a) Basic structure of IEEE-488 / GPIB system.]

Er Upendra yadav
Pokhara university

Unit - VI

[5 hrs]

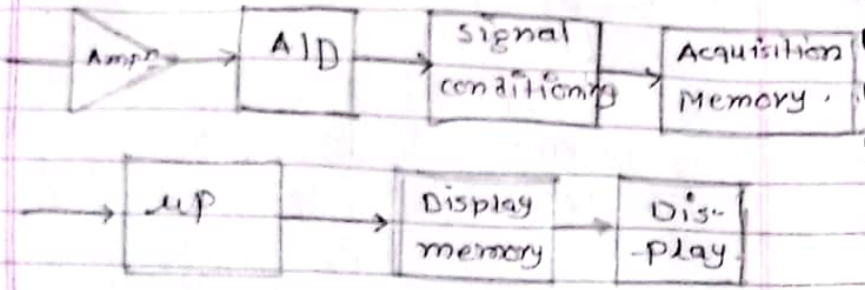
Recorders, Displays and Storage Devices :-

Fundamentals of cathode ray oscilloscope :-

An ocilloscope is a Labratory instrument commonly used to display and analyze the waveform of electronic signals. In effect, the device drawn a graph of the instantaneous signal voltage as a function of time. Engineers are used an oscilloscope to measure phenomena and solve the measurements challenges quickely and accurately to verify their designs or confirm that a sensor is working properly. There are three primarly oscilloscope systems which are given belows.

(a) Vertical system.
(b) Horizontal system.
(c) Trigger system.

All this systems provide information about the electrical signal. So the oscilloscope can accurately reconstruct it. The oscilloscope Block diagram given belows.



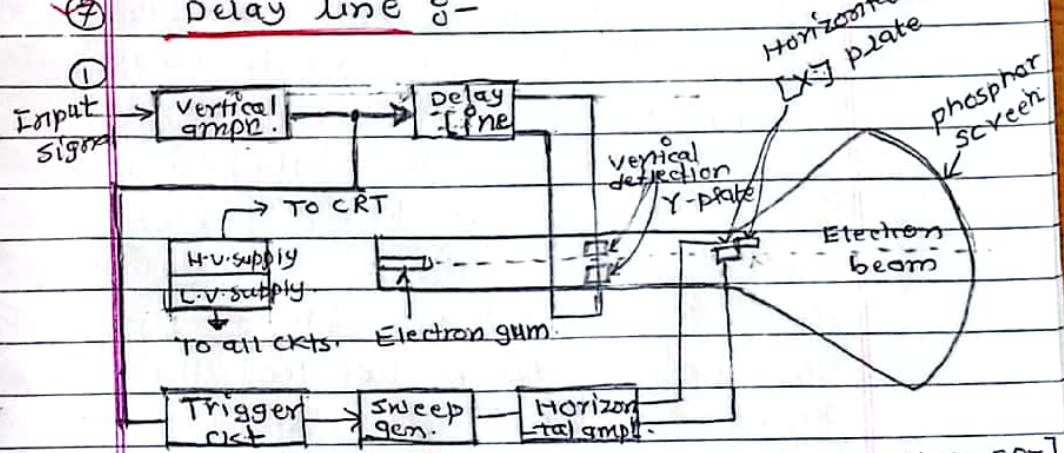
[fig-④ Block-diagram of oscilloscope]

The first stage attenuates or amplifies the signal voltage in order to optimize the amplitude of the signal. This is known as a vertical system since it depends on the vertical scale control. Where A|D converter used to sample the signal voltage and converted it in a digital format value. The Horizontal system, which contains a sample clock, gives each voltage sample a precise time [Horizontal coordinates]. The semple clock drives the A|D converter its digital output is stored in the acquisition memory as records points. The Trigger system detects a user-specified condition in the incoming signal stream and applies it as a time reference in the waveform record. The event that met the trigger cirteria is displayed.

Block diagram of oscilloscope :-

Block diagram of general-purpose oscilloscope [CRO]. It consists of the following major systems :-

1. Cathode Ray tube [CRT] :-
2. Vertical amplifiers :-
3. Horizontal amplifiers :-
4. Sweep and Time base generator :-
5. Trigger circut :-
6. High and Low voltage supply :-
7. Delay line :-



[fig-⑤ Block-diagram of a general purpose CRT]

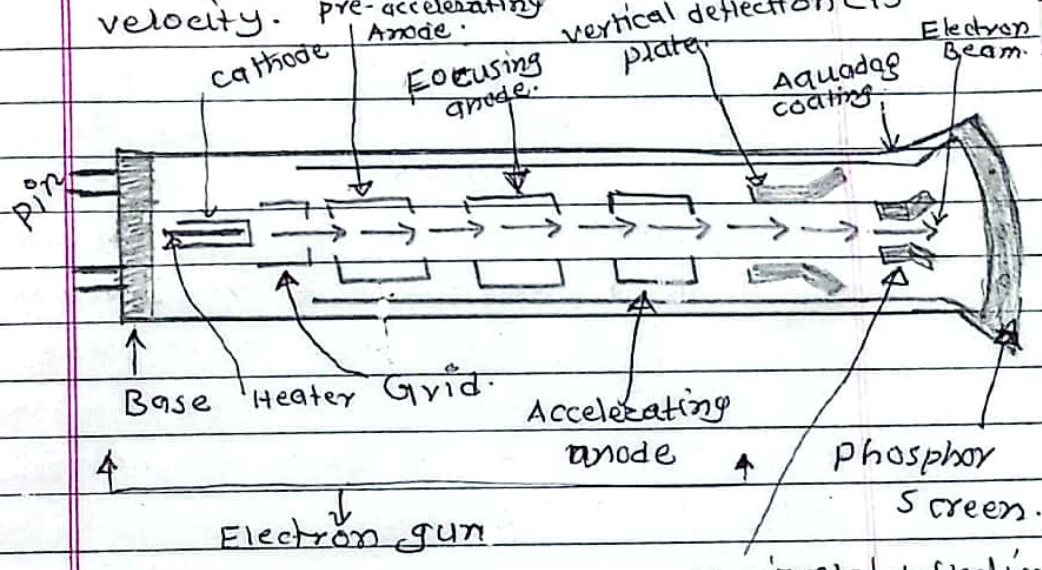
① Cathode ray tube [CRT] :-

A cathode ray oscilloscope consists of a cathode ray tube [CRT] which is heart of the oscilloscope and some additional circuitry to operate the CRT. The main part of CRT are

ⓐ Electron gun assembly :-
ⓑ Deflection plate assembly :-
ⓒ Fluorescent screen :-
ⓓ Glass envelope :-

The electron gun assembly produces a sharply focussed beam of electrons which accelerated to high velocity. This focussed beam of electrons strikes the fluorescent screen with sufficient energy to cause a luminous spot on the screen.

After leaving the electron gun, the electron beam passes through two pairs of electrostatic deflection plates. voltage applied to these plates deflect the beam. voltage applied to one pair of plates move the beam vertically up and down and the voltage applied to the other pair of plates move the beam horizontally from one side to another. Focusing anode is used to focus the beam on the screen and the accelerating anode makes the electron beam to move with high velocity.

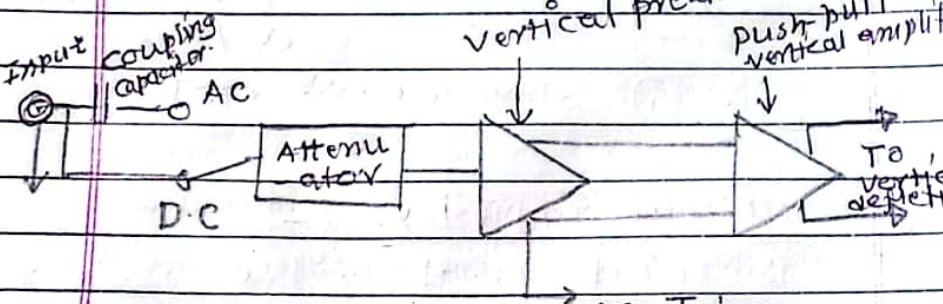


[fig-ⓐ structure of CRT.]

② vertical amplifiers :-

The input signal is fed to Y-deflection plate through a vertical amplifier.

The function of vertical amp^{n} is to amplify the input signal. It may consist of several stages in cascade and generally, operates with fixed gain. The output stage of this amp^{n} is invariably a push-pull amplifier. It is necessary to adjust the magnitude of the input signal so that a large signal may not cause to the display to go out of screen. Therefore, the input signal is fed to the vertical amplifier through an attenuator. The attenuator is a network of resistances and capacitances and it reduces the input signal so that the display of large input signals may not go out of the screen.



[Fig-① Block diagram of vertical section of oscilloscope.]

The input converter feeds an input attenuator, after which follows the vertical amplifier. The input impedance of an oscilloscope is rather high being on the order of 1 MΩ, which is desirable for measuring voltage in high impedance ckt. The attenuator set the sensitivity of the oscilloscope in the common 1-2-5 sequence ie the input attenuator could provided 10, 20, 100, 200 mV etc per centimetre. Practically, all oscilloscopes provided a switchable input coupling capacitor. This is provided so that measurements of A-C. signals may be viewed in the presence of high D.C voltage by including the coupling capacitor. When D-C. measurements are to be made, the capacitor may removed. The value of the capacitor is chosen so that the frequency response of all the oscilloscope is preserved down to a few Hz.

The vertical amp^{n} is the principal factor in determining the sensitivity and Bandwidth of an osalloscope.

The gain of the vertical amp^{n} determines the smallest signal that the oscilloscope can satisfactorily reproduce on the CRT screen. The sensitivity of an oscilloscope is directly proportional to gain of the vertical amp^{n} that is as gain increase sensitivity increased which allows us to observed small signal amplified. The vertical sensitivity of an oscilloscope is deflection factor that can be selected with rotary switch. The band-width of an oscillo-scope is determine the range of frequencies that can be observed by the instruments.

(3) Horizontal amplifiers :-

The function of the horizontal amp^{n} is to be amplify the signal applied to the X-plate. The amplifier consists of several stage in the cascade.

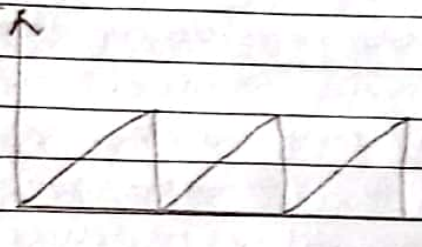
For measurement of voltage and currents the input to the horizontal amp^{n} is a sawtooth wave for frequency and phase measurements, the input is an external signal. The horizontal amp^{n} should be capable of amplifying both these inputs without distortion.

(4) Time Base or sweep generator :-

In horizontal deflection plate x-plate are not energised, the electron beam would draw a vertical line on the screen. The function of time base generator is to drive the beam at a steady speed across the screen and when it is reached the right-hand side of the screen, the beam is made to fly back to the starting position on the left-hand side of screen. The time base generator produced the saw-tooth wave which are given below, then of the same freq. as the input signal to the Y-plate The horizontal deflection of the beam is proportional to the instantaneous voltage.

of saw-tooth wave. The beam sweeps at a uniform rate across the screen in horizontal direction. Running to the starting position almost instantaneously and sweeping again.

The time base generator gives an output sweep signal of adjustable freq. so that the Y- input signals of a wide range of frequency may be displayed on the screen. No needs of external input signal to the X- plates.



[Fig-② saw-tooth wave]

Four types of sweeps :-

① Free running sweep ② Triggered sweep. ③ Driven sweep. ④ Now- saw-tooth sweep.

④ Delay line :- It is used to delay the signal from some time in vertical section. comparing the vertical and horizontal deflection ckt in the oscilloscope block diagram. we observe that the deflection signals is initiated or triggered by a portion of the output signal applied to the vertical CRT plates. signal processing in the horizontal channel consists of generating and shaping a trigger pulse that starts the sweep generator, whose output is fed to horizontal deflection plate. This whole process takes time on the order of 80ns. To allow the operater to observe the leading edge of the signal waveform, the signal drive for the vertical CRT plates must therefore be delayed by atleast the same amount of time. This is function of time delay line.

CRO probes :- The CRO probe performs the very important

Function of connecting the test ckt to the oscilloscope with altering and Loading. There are three different probes which are given below

1. Direct Reading probe :-
2. ckt Isolation probe :-
3. Detector probe :-

1. Direct Reading probe :-
This probe is the simplest all probes and it uses a shielded coaxial cable. It avoids stray pickups which may Lead to problems when low level signals are being measured. It is usually used for low freq and low impedance ckt. However in using the shielded probe,

b. ckt Isolation probe :- ckt Isolation probe is used in order to avoid the undesirable ckt loading effect of shielded probe. Isolation probe which is used alone with the capacitive voltage divider, decreases the input capacitance and increases the input resistance of the oscilloscope This way the loading effects are drastically reduced.

3. Detector probe :- when analyzing the response to modulated signals in communication equipments like AM, FM and TV receivers, The detector probe functions to separate the lower freq modulation components from higher freq carrier. The amplitude of modulated carrier is displayed on the oscilloscope by by rectifying and bypassing action.

Specification of an oscilloscope :-

1. Bandwidth :-
2. Sample Rate :-
3. Memory size / Depth :-
4. Rise Time :-
5. channels :-
6. Trigger :-

(1) **Bandwidth :-** probably the most important specification of an oscilloscope is its bandwidth. As the freq of the signal gets closer to the maxm freq. that the oscillos-cope can work with its accuracy drops.

(2) **sample rate :-** The sample rate is the number of samples that the oscilloscope is capable of capturing per second. The higher sample rates require more and faster memory to store.

(3) **Memory size / Depth :-** Very closely related to the oscilloscope sample rate is its memory size. It stores the waveform data in its memory.

(4) **Rise time :-** The Rise time of an oscilloscope describes the ability of the instruments to detect and capture rapidly rising and falling signals.

(5) **channels :-** Each channel has a separate connector where you can attach a probe and through this probe to monitor a signal. oscilloscopes having 2 or 4 - channels.

(6) **Trigger :-** The Trigger of an oscilloscope is fundamental to its operation. The Trigger is the mechanism through which the oscilloscope can recognise a specific attribute of the input signal.

Oscilloscope Measurement Techniques

(1) voltage Measurements :-

(2) Time Measurements :-

(1) **voltage Measurements :-**

voltage is the amount of electric potential, expressed in volts, usually one of these points is ground zero volts. but not always. voltages can be measured from peak-to-peak. ie, maxm point of a signal to its minm point.

① Peak to peak value V_{p-p} = $\frac{\text{volts}}{\text{div}}$ × no. of div.

② Amplitude [V_{max}] = $\frac{V_{p-p}}{2}$.

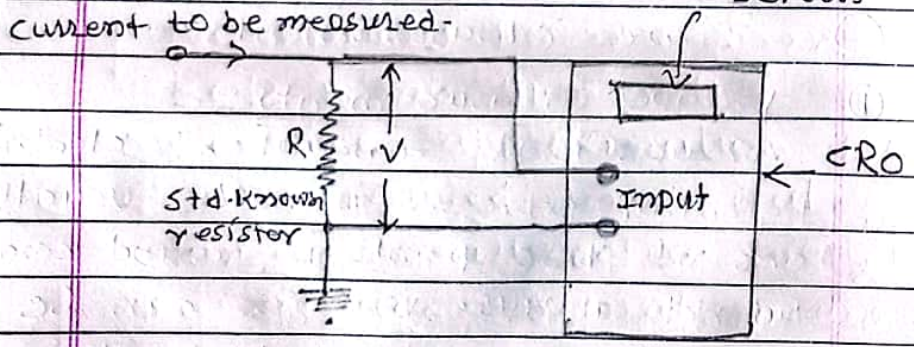
③ R.M.S. value [$V_{r.m.s}$]

$$V_{r.m.s} = \frac{V_{p-p}}{2\sqrt{2}}$$

[For sinusoidal signals only]

② Current Measurements :-

A CRO has very high input impedance and cannot be used for direct measurements of current, However the current can be measured in term of voltage drop across a std. resistance



[fig-① current measurements]

$$I = \frac{V \text{ [measured on CRO]}}{R}$$

For, measurement of high freq. currents, the shunt should be non-inductive.

Special oscilloscopes :-

① Digital storage oscilloscopes :-

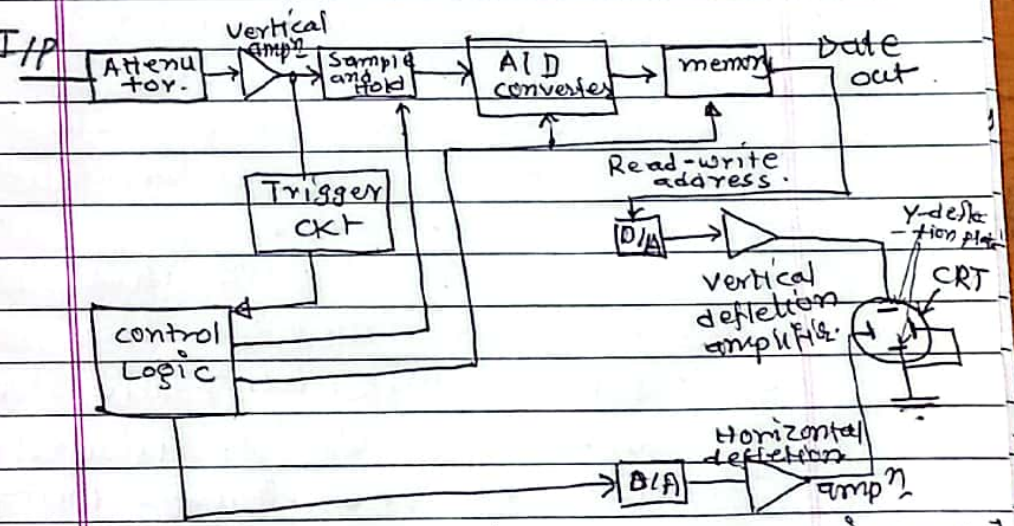
② Sampling oscilloscopes :-

① Digital storage oscilloscopes :-

The digital storage oscilloscopes is a superior method of trace storage. In this technique, the waveform to be stored is digitized, stored in a digital memory and retrieved For display on the storage oscilloscope. The stored display can be displayed indefinitely as long as power is applied to the memory which can be supplied with small battery.

The block diagram of a digital storage oscilloscope is given belows.

The input is amplified and attenuated with input amplifier The digital storage oscilloscope uses the same types of input circuitry and oscilloscope probes as conventional oscilloscope, and many digital storage oscilloscopes can operates in a conventional mode bypassing the the digitizing and storing feature. The output of the input signal amplifier feeds an A/D converter. The main requirement of A/D converter is its speed, while accuracy and resolution are of secondary importance. The digitized output is in the binary form and not BCD form. Generally, Successive approximation type of ADC is used in digital storage oscilloscope. Digitizing the analog signal means to take samples of the input signal at periodic interval of time. The sampling rate should be greater than twice the higher freq. present in the input signal so that sampling theory satisfied. The selection of the sampling rate and memory size depends on the type of wave form being recorded As analog signal is sampled at suitable rates. A continuous storage oscilloscope consists of a feature called Pretrigger view. This indicates that the events that occurred before the trigger input signal was applied, are displayed This selection is a % selection. This mode is useful when failure occure.



[fig-④ Digital storage oscilloscope]

The digital storage oscilloscope has the following three modes of operation.

1. Roll mode :-
2. Store mode :-
3. Hold or Save mode :-

Advantage

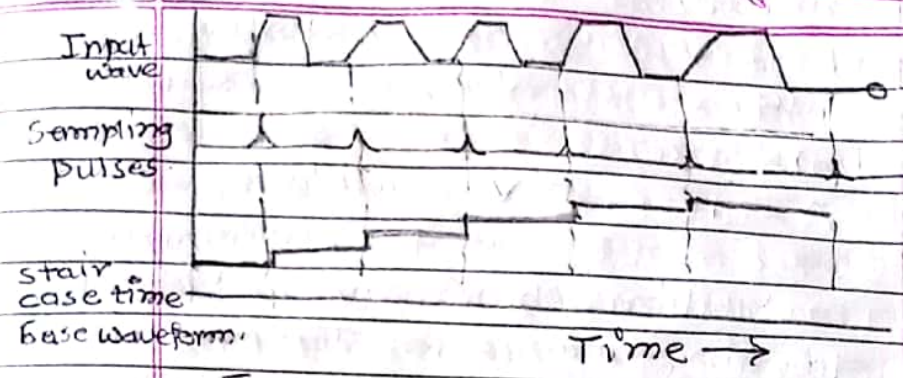
1. Infinite storage time.
2. Easy to Operate
3. signal processing is possible.
4. It is capable of displaying X-Y plots, P-V diagram and B-H curve.
5. cursor measurements is possible.

Application :-

1. It can be used to measure. AC as well as DC voltages and currents. freq. time period, time interval bet? -two signals etc. inductance, capacitance.
2. It is used to give the visual representation for a target such as arroplane, ship.
3. In medical fields, it is used to display cardiogram that are useful for diagnosis of heart of patient.
4. It is used to Observe the Radiation pattern generated by transmitting antenna.
5. Analyse TV waveform.
6. It can be used to determine the modulation char? and detect the standing waves in Transmission lines.

2. Sampling oscilloscope :-

Sampling technique have to be employed to obtain suitable display and CRO employing such sampling methods are called sampling oscilloscop-e. The display is made up from as many 1000 dots of luminescence. The vertical deflection for each dot is obtained from progressively later points in each ... succ-essive cycles of input waveform. as shown fig-@ below. The horizont-al deflection of the electron beam is obtained by application of stair case waveform to X-deflection plate. shown in display of dots,



[fig-ⓐ sampling principle.

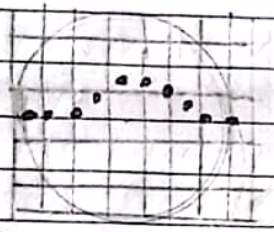
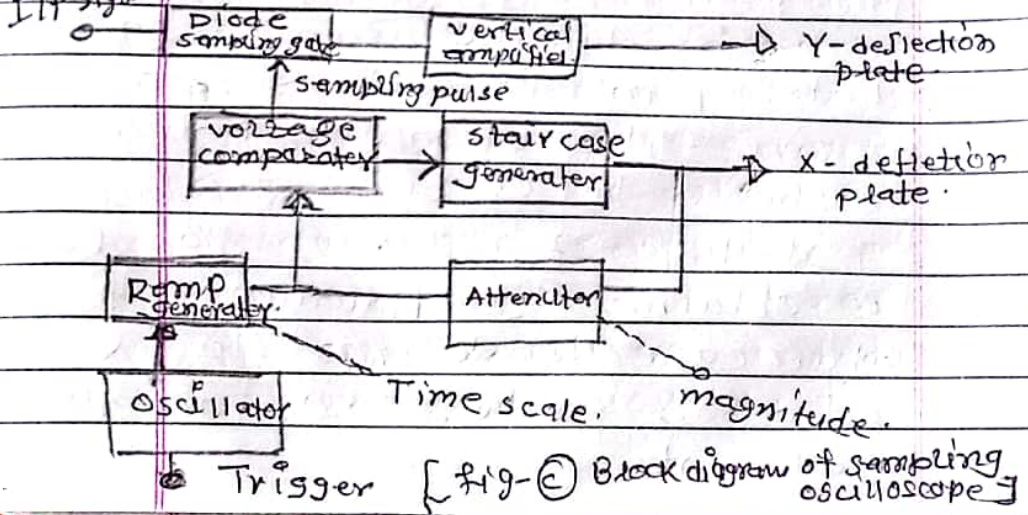


fig-ⓑ Display of dots.



[fig-ⓒ Block diagram of sampling oscilloscope]

The input is applied to the diode sampling gate. As the start of each sampling cycle a trigger input pulse is generated which activates the blocking oscillator. The oscillator output is given to the ramp gen. which generates the linear ramp signal, since the sampling must be synchronized with the input signal freq. the signal is delayed in the vertical amplifier. The staircase generator produced a staircase wave form which is applied to an attenuator. The attenuator controls the magnitude of the staircase signal and then it is applied to a voltage comparator. Another input to the voltage comparator is the output of the ramp generator. The voltage comparator compares the two signals and produces the output pulse when the two voltages are equal. This is nothings but a sampling pulse which applied to sampling gate through the gate control circuitry.

This pulse opens the diode gate and the sample is taken in. This sampled signal is then applied to the vertical amplifier and the Y-deflecting plate. The output of the staircase generater is also applied to the X-deflecting plate. During each step of staircase the spot moves on the screen. The comparater output advances the staircase output through one step. After the certain number of pulses about 100 or so the staircase generater reset. the smallest the size of the steps of the staircase generater, Large is the number of sample and higher is the resolution of image. The sampling oscilloscope responds and stores rapid bits information and display's them continuously.

It is this quality of sampling oscilloscopes which has limited sensitivity, Bandwidth and small display size. The sampling method transforms the input signal into lower freq. range, where low freq circuitry is than capable of producing an effective display.

Advantages :-

1. The display produced is clear
2. High speed electrical signal produced.
3. very high freq performance can be achieved.
4. To controlling the size of step of the staircase generator the number of samples and hence the resolution can be controlled.
5. The sampling technique allows the design of the oscilloscope with wide bandwidth, high sensitivity even for low duty cycle pulses.

Limitation :-

The sampling oscilloscope cannot used to display the Transient waveforms.

Recorders :-

A Recorder records electrical and Non-electrical quantities as a function of time. The record may show how one variable varies with respect to another or how the input signal varies with time.

The record serves the following objectives :-

1. It preserves the details of measurements at a particular time.
2. It provides at a glance the overall picture of the performance of unit.
3. It provides immediate reflection on the action taken by the Operater.

Types of Recorders :-

(f) Analog Recorders :-
(i) Graphic recorders :-
(a) Galvanometer Type
(b) Null Type
(c) potentiometric Recorders
(d) Bridge Recorders.
(e) LVDT Recorders.
(ii) Circular chart Recorders :-
(iii) X-Y Recorders.

(g) Magnetic Type Recorders :-
(h) oscillographic Recorders :-
(B) Digital Recorders :-
(I) Incremental Digital Recorders :-
(ii) synchronous Digital Recorders :-

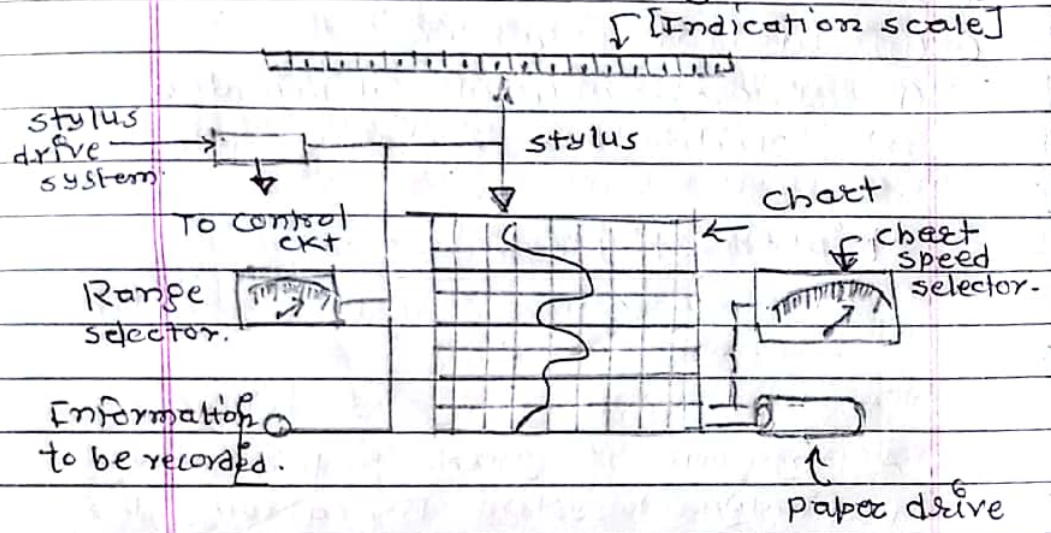
Strip chart Recorders :-

The basic construction features of strip chart Recorder :-

A strip chart consist of following:
A long wall of graph paper moving vertically. A system for driving the paper at some selected speed. A stylus for marking paper on the moving graph paper. [Most recorders use a pointer attached to the stylus which pointer moves over a calibrated scale thus showing instantaneous value of the quantity being measured].

A stylus driving system which

moves the stylus in nearby exact replica or analog of quantity being measured. [A spring wound mechanism may be used but in most of recorders a synchronous motor is used for driving the paper].



[Fig-④ strip-chart Recorders]

Marking mechanisms:- The most commonly used mechanisms employed for marking marks on the paper are:

① marking with ink filled stylus
② marking with heated stylus.
③ chopper bar.
④ Electric stylus marking
⑤ Electrostatic stylus.
⑥ optical marking method.

Tracing system:- For producing graphic representations two types of tracing system are used.

④ curvilinear system.
② Rectilinear system.

There are various kinds of strip chart recorders. According to working principle, These are mainly divided into two categories which are given belows:-

① Galvanometric Type:-
② potentiometric Type:-
① Galvanometric Type:-

This type of recorder operates on the deflection principle. The deflection is produced by a galavanometer [D'Arson val] which produces torque on account of a current passing through its coil. This current is proportional to the quality being measured. These recorders can work on ranges for Few mA to several mA or From a Few mV to several mV.

The moving galvanometric type recorder is comparatively inexpensive instruments having narrow bandwidth of 0 to 10 Hz. It has a sensitivity of 0.4 mV/mm or from a chart of 100 mm width a full scale deflection of 40 mV obtained. Lineal amp!! are used for measurem-ent of smaller voltages. This-type of recorder is not useful for recording fast variations in either current or voltage or power.

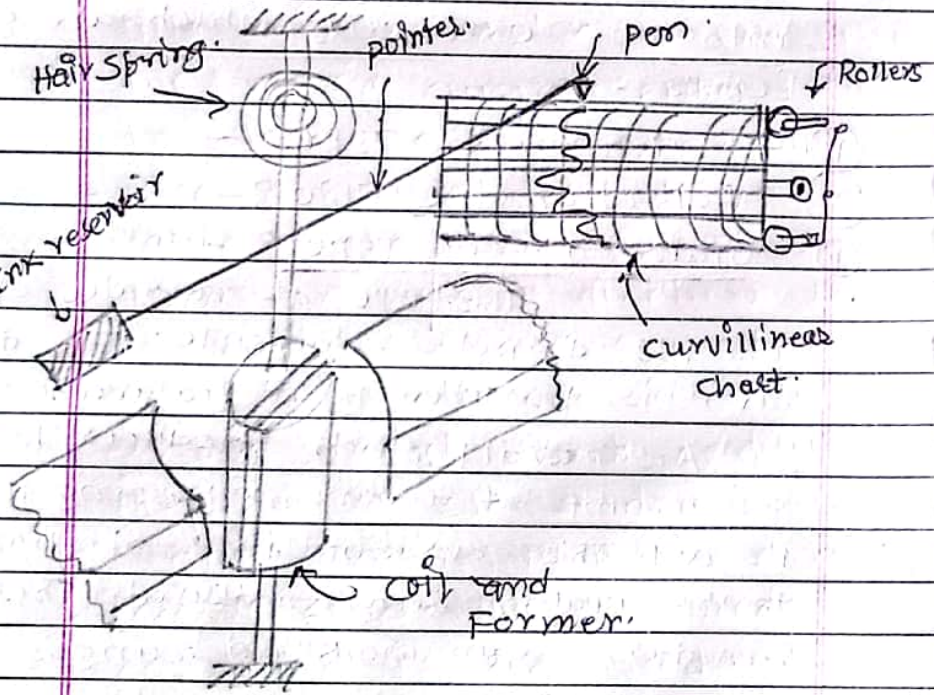


fig-(a) Galvanometer-type recorder.

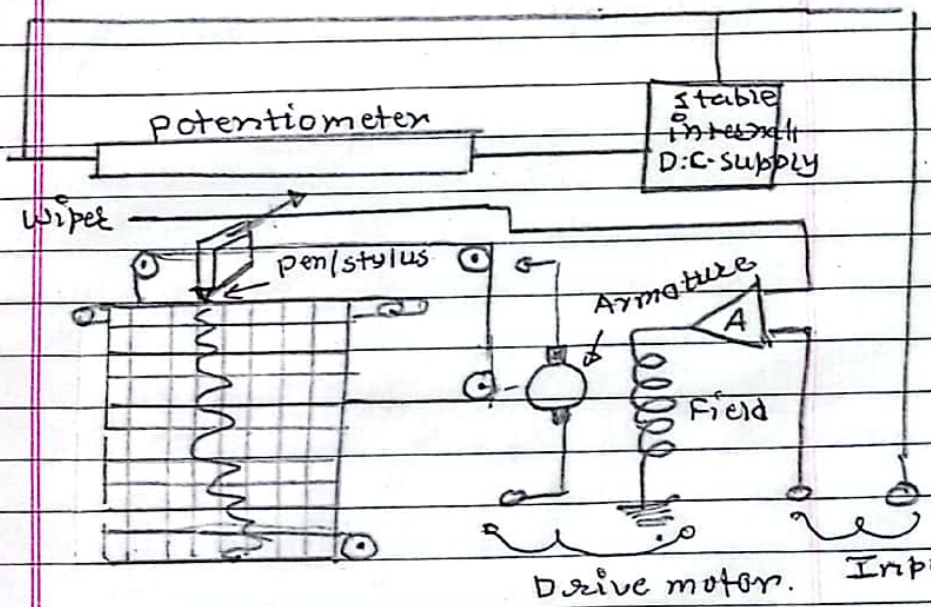
Some recorders contain a timing mechanism that prints a series of small dots along the edge of the paper chart as the paper moves through the recorder. This time marker produces one mark per second. These types of recorders are mostly used as optical recorders, and contain Light source provided by either an ultra violet or Tungsten Lamp. A small mirror is connected to the galvanometer movement and light beam is focused on the mirror. The beam reflected from the mirror is focused into a spot on a light sensitive paper. As the current passes through the coil the mirror deflects the movement of the light beam is affected by the deflection of the small mirror and the spot on the paper also varies For the same reason, Thus tracing the ... waveform on the paper.

(2) Potentiometer Recorders:- A potentiometer recorder is used

where input signal to the recorder is a D.C. voltage. This potentiometer can be converted to recorder by attaching a stylus to the sliding contact. This stylus moves over paper and thus records the quantity under measurements.

During the operation of the recorder, the error signal is amplified and subsequently the field coil of D.C motor is energised. The error current either flows in clockwise direction or anticlockwise direction depending on the value of the voltage. The motor turns in such a direction that it reduces error signal to achieve balanced condition. As error signal start reducing, the motor slows down and stops completely when error become zero. Thus Balanced condition is achieved.

The pen which is used for marking waveform is mechanically coupled to a wiper which in turn is mechanically coupled to the armature of D.C. motor. Thus, when wiper moves according to the error signal, so the pen also moves in the same direction. As a result, the pen records the input signals variations moving across the paper.



[Fig-@ potentiometer Recorders]

Such recorders have very high Input impedance.

infinity at balance conditions. and high sensitivity of the order of 4V/mm with an error of less than ± 0.25% with Bandwidth of 0-8 Hz.
The most common application of potentiometric recorder is for recording and control of process temp. self-balancing pot. are unduly used in industry.

Magnetic Type and Disc Recorders

Magnetic type recorders are used for high frequency signal recording. In this record. ers, the data is recorded in a way that it can be reproduced in electrical form any time. Also main advantage of these recorders is that the record-ed data can be replayed for almost infinite times. Because of good higher freq. response.

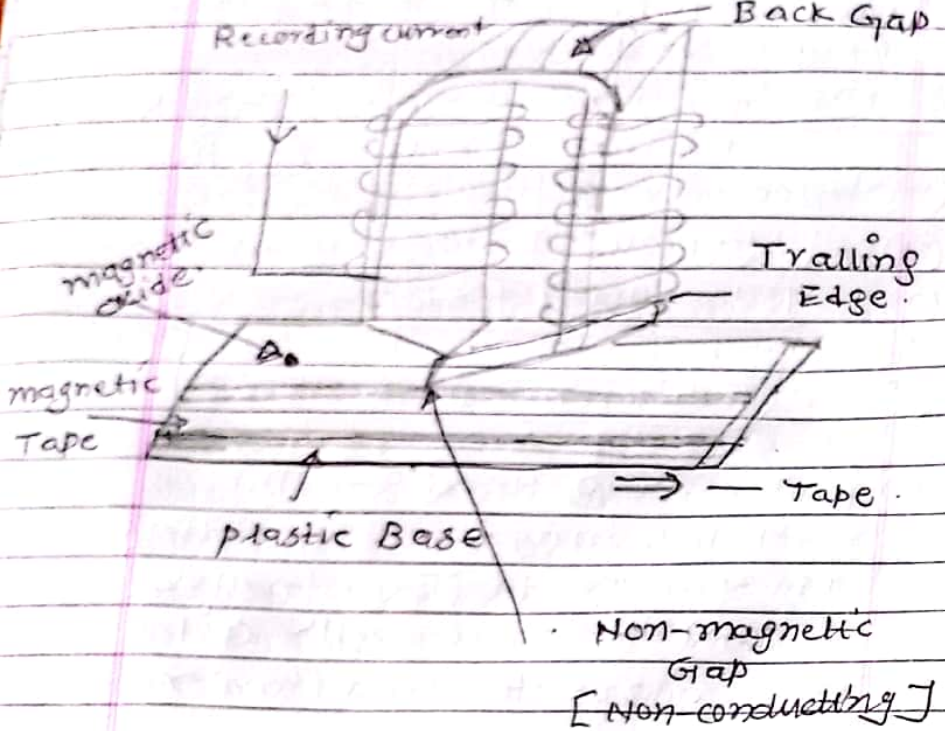
Basic components of Tape Recorder:

magnetic Tape Recorder components:-

1. Recording Head:-
2. Magnetic Tape:-
3. Reproducing Head:-
4. Tape Transport Mechanism:-
5. conditioning Device:-

1. Recording Head:- The construction of the magnetic recording head is similar to Transformer having a toroidal core with coil when the current used for recording

is passed through coil wound around magnetic core. It produced magnetic flux. when the tape is passing the head, the flux produced due to recording current get linked with iron oxide particles on the magnetic tape and these particles get magnetized.



This magnetization particle remain as it is, even though the magnetic tape leaves the gap. The actual recording takes place at the trailing edge of the air gap. Any signal is recorded in the form of the patterns. These magnetic patterns are dispersed any where along the length of magnetic tape is accordance with variation in recording current w.r.t time.

(2) Magnetic Tape :- The magnetic tape is made of thin sheet of tough and dimensionally stable plastic ribbon and is wound around a reel. This tape is transferred from one reel to another. when tape passes across air gap magnetic pattern is created in accordance with variation of recording current. To reproduced this pattern, the same tape with some recorded pattern is passed across the another magnetic head in which

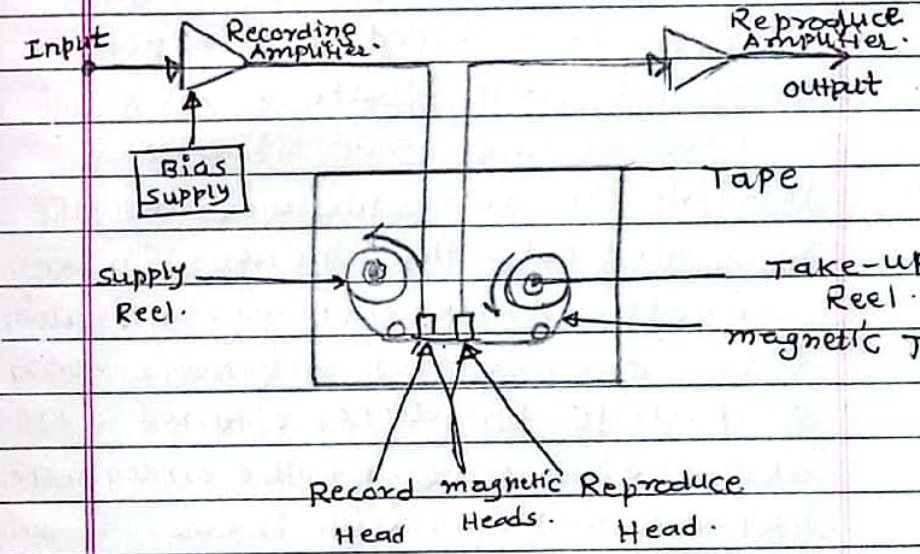
voltage is induced. This voltage induced is in accordance with the magnetic pattern.

③ Reproducing Head :- The use of Reproducing head is to get the recorded data played back. The reproducing head detect detects the magnetic pattern recorded on the tape. The head converts the magnetic pattern back to the original electrical signal. In appearance, both recording and reproducing heads are very much similar.

④ Tape Transport mechanism :-

The tape Transport mechanism moves the magnetic tape along the recording head or reproducing head with constant speed. The magnetic tape is wound on real. There are two reels; one is called as supply & other is called as take-up reel. Both the reels rotate in same direction.

The Transportation of the tape is done by using supply reel and take-up reel. The fast winding of the tape or the reversing of the tape is done by using special arrangements. The rollers are used to drive and guide the tape.



⑤ conditioning Device :- These devices consit of amplifiers and fitters to modify signal to be recorded.

Principle of Tape Recorders :-

when magnetic tape is passing through a recording head, The signal to be recorded appears some magnetic pattern on the tape. This magnetic pattern is in accordance with variation of origional recording currents.

The recorded signal can be reproduced back by passing the same tape through a reproducing head where the voltage is induced corresponding to the magnetic pattern on the tape.

when the tape is passed through the reproducing head, The head detects the changes in the magnetic pattern ie magnetization The change in magnetization of particle produced change in the reluctance of the magnetic ckts of reproducing head, inducing the voltage in its winding.

The induced voltage depends on the directions of magnetization and its magnitude on the tape

The e.m.f induced is proportional to the rate of change of magnitude of magnetization

$$e = N \frac{di}{dt}$$

where,

N = No. of turns of winding on reproducing head.

suppose signal is recorded is $V_m \sin \omega t$ Thus, The current in the recording head and flux induced will be proportional to this voltage. It is given by

$$e = K_1 V_m \sin \omega t$$

where

K_1 = constant.

Above the pattern of Flux is recorded on the tape. Now, when this tape is passed through the reproducing head, above pattern is regenerated by inducing voltage in the reproducing head winding. It is given by

$$e = K_1 U V_m \sin \omega t$$

Thus the reproducing signal is equal to derivative of input signal & it is proportional to flux recorded & freq. of recorded signal.

Application of magnetic Tape Recorders :-

1. Recording of stress, vibration and analysis of noise.
2. Communication and spying.
3. Data recording and analysis on missiles, aircraft and satellite.

Indicators and Display Devices - Nixie, LED, LCD and seven-segment and Dot matrix Display:

Nixie Tube :- A Nixie tube or cold cathod display is an electronic device used for displaying numerals or other information using glow discharge. Nixie tubes are display device that were popular in mid of 20th century They use neon-gas-filled tubes with cathodes shaped like numerals or symbols. The tube filled with a gas with low pressure, mostly neon and a small amount of argon, in a penning mixture. When voltage is applied, a specific cathode light up, displaying the corresponding character. Nixie tube have a vintage aesthetic and emit a warm orange glow. They are often used in retro-style clocks and other decorative applications.

It's operation does not depend on thermionic emission of electrons from a heated cathod. It is hence a cold-cathod tube and is a variant of the neon lamp. such tubes rarely exceed 40°C [104°F] even under the most severe of operating conditions in a room at abient temp. Vacuum fluorescent displays from the same era use completely different technology. They have heated cathod together with a control grid and shaped phosphor anode. Nixies have no heater or control grid, typically a single anode and shaped bare metal cathodes.

Data logger

Data loggers are is stand-alone device that can record information eletronically from internal or external sensors or other equipment that provided digital or serial output.

Features of Data loggers :-

① stand-alone operation :-

Most data loggers are normally configured with a PC, some models can be configured from the front panel provided by the manufacture once the data loggers are configured they don't need the PC to operate.

② support for multiple sensor type :-

Data loggers often have universal input type which accept input from common sensors like Thermocouple, RTD, humidity, voltage

③ Local data storage :-

All the data loggers have local data storage and internal memory unit. so all the measured data storaged within the Logger for later Transfer to PC.

④ Automatic Data collection:

Data loggers are designed to collect data at regular interval, 24 hours a day and 365 days a year. If necessary, and the collection made is often configurable. Data logging and recording are both analog terms in Fields of measurements. Data logging is basically measuring and recording of any physical phenomena or elerical parameter over a period of time. The physical phenomena can be Temp; strain, displacement, flow, pressure, voltage, current resistance, power and many parameters etc.

The data loggers converts the signal to help of A/D converters.

Basic component of Data Loggers:-

① Hard components like sensors signal conditioning and A/D converters etc.

② Long term data storage, on PC.

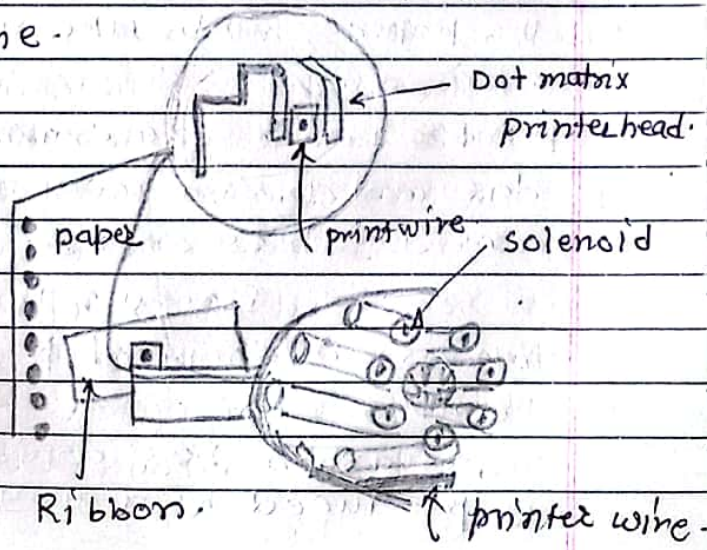
③ software for collecting data analyzing and viewing.

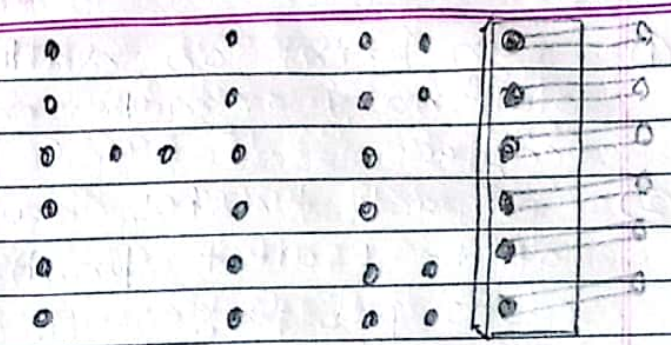
Dot Matrix :-

A Dot matrix printer or Impact matrix printer refer to a type of computer printer with a print head that runs back and fourth on the page and prints by impacts striking an-ink-soaked cloth ribbon against the paper, much like a typewriter. unlike a typewriter or daisy wheel printer Letters are drawn out of a dot matrix. varied fonts and arbitrary graphics can be produced.

Because the printing involves mechanical pressure, these printers can create carbon copies and carbon less copies. Each dot is produced by a tiny metal rod,

also called a 'wire' or pin which less copies. Each dot is produced by a tiny metal rod also called wire or pin. which is driven Forward by the power of a tiny electromagnet or solenoid Either directly or through small levers [pawls]. Facing the ribbon and the paper is a small guide plate pierced with holes to serve as guides For pins. The moving portion of the printer is called the print head and when running the printer as text device it generally prints one line of text at a time.





Most dot matrix printers have a single vertical line of dot making equipment on their print heads. others have a few interleaved rows in order to improve dot density. These mlc can be highly durable, but eventually wear out. Ink invades the guide plate of the print heads, causing grit to adhere to it. This grit slowly causes the channels in the guide plate to wear from circles into ovals or slots, providing less and less accurate guidance to the printing wires.

Disadvantage:-

① Impact printers are usually noisy.

② They can only low resolution graphics with limited color performance.

Advantage :-

① can print on multi-part stationary or make carbon copies.

② Impact printer have one of the lowest printing costs per page.

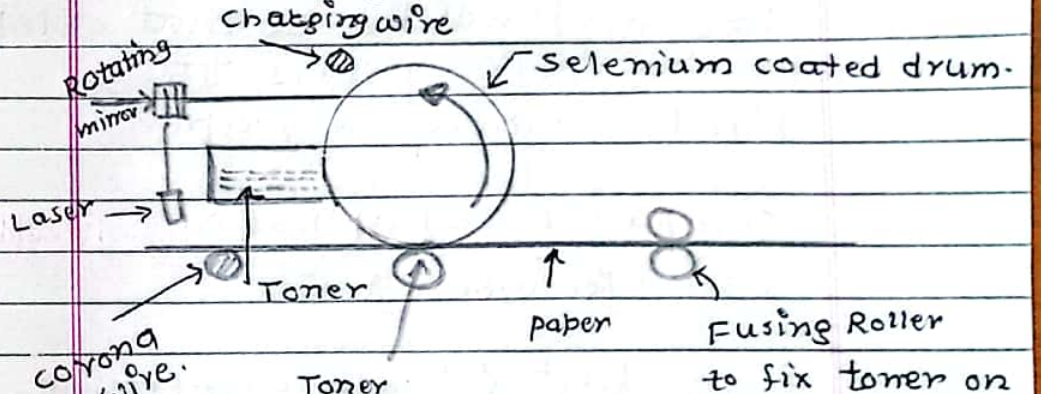
③ They are able to use continuous paper rather than requiring individual sheets.

④ The ink ribbon also does not easily dry out.

Laser printer :-

It has a photosensitive drum which is coated with selenium based light sensitive material. The selenium, in the dark, has a high resistance and consequently becomes charged as its passes close to the charging wire; This is a wire at hight voltage and off which charge leaks.

A light beam is made to scan along the length of the drum by a small rotating eight-sided mirror. when light strikes the selenium its resistence drops and it can no Longer remain charged. By controlling the bright of the beam of light the point on the drum can be discharged or Left charged.



[Fig-⑨ Laser printer's basic Elements]

As the drum passes the toner reservoir, the charged area attract particles of toner which thus stick to the areas that have not been exposed to light

and donot stick on the areas that have been exposed to light. The paper is given a charge as it passes another charging wire, the so called corona wire, so that as it passes close to drum it attracts the toner off the drum. A hot fusing roller is then to melt the toner particles so that, after passing bet" rollers, They finely adhere to paper.

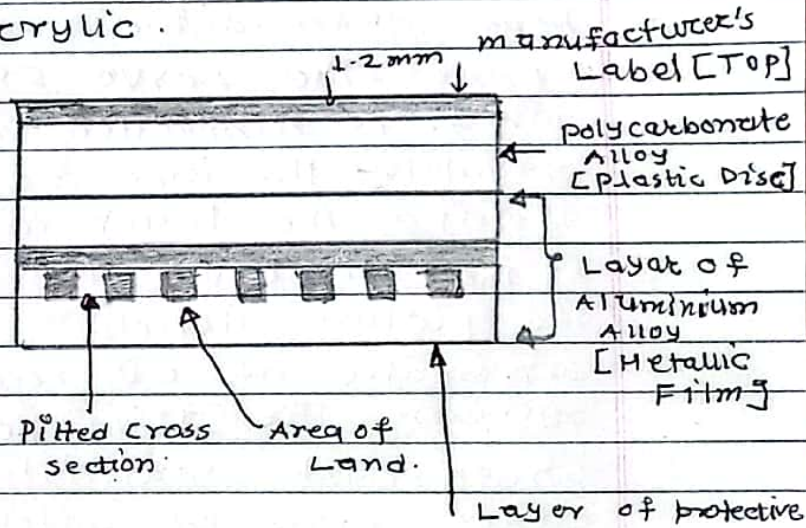
Compact Disc / Optical Disc Recorders :-

A compact Disc is a portable storage medium that can record, store and play back audio, video and other data in digital form. As the results, the signals captured are a replica of the original audio stream. Text, picture images audio, video and software are all stored on compact discs. It is made up of the three Layers.

(1) Transparent substrate with polycarbonate water [plastic disc] makes up this layer.

(2) Thin metallic layer coating of aluminium alloy is applied to the water base.

(3) outer layer of protective Acrylic.

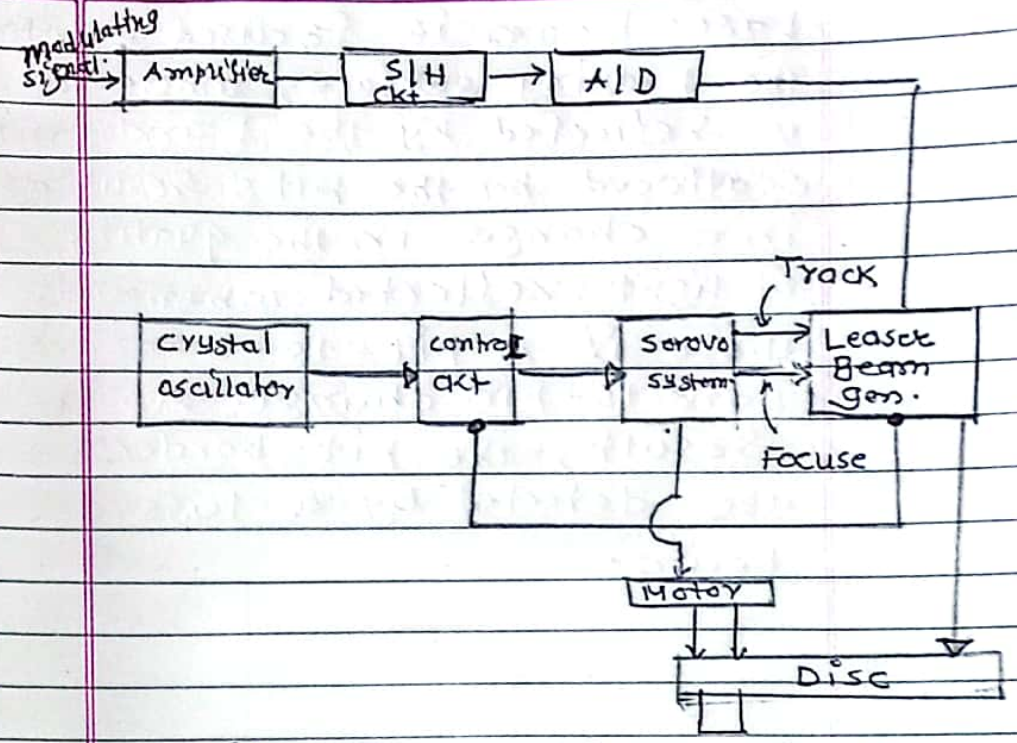


[Fig-A Layout CD-ROM Disc]

Working principle :- The using a

Sample and Hold ckt and an ADC the signal to be recorded on CD is first amplified and then transformed into digital signal. The output of the ADC is also used by the Laser Beam generator. The control ckt and the servo system are both controlled by the signal from the crystal oscillater and Laser beam generator.

The servo system, which is controlled by a motor regulates the disc rotation as well as the track and focus of the Laser beam generator. The picture depicts a block schematic of CD recording system. The unexposed photoresist materials is chemically removed after leaving a helical pattern across the glass disc's surface. This becomes the glass master - production CDs



[Fig-① Block diagram of CD Recording]

The data retrieval system is made up the the phase listed below.

① servomechanism which spins the CD.

② A Laser head that moves in a radial pattern. The Laser head can both emit and detect a 70 nm laser beam.

When the disc spin, the Laser beam is focused into the playing surface, where it is reflected by the Lands and scattered by the pits resuting in a change in the quality of light reflected whenever there is a pit-to-Land or Land-to-pit change. As a result, the pit borders are detected by a laser beam: