Basics of Measurment -

The measurment of a given quantity is essentially an act or the result of comparision between the quantity and predefined Standard. Since two quantities are compared the result is expressed in numerical values.

Measurment is the process by which one converted physical parmeters to meaningful numbers.

Methods of measurment -

Two basic methods of measurments.

1)- Direct 2)- Indirect.

* Direct method of measurment the unknown quantity is directly compared against a standard.

* Measurment by direct method are not alway possible feasible and practicable. These methods in most of the cases are inaccurate because they involve human factors. They are less sesitive or accurate. Hence Direct method are not prefered and rarely used.

In engineering applications measurment use indirect method of measurment.

Types of instruments – Three types of instruments used.

1) - Mechanical Instruments
2) - Electrical Instruments
3) - Electronic Instruments

* Mechanical instruments are very reliable for static and Stable Conditions. But they suffer from a very major disadvantages. which is because they are unable to respond rapidly to measurment of dynamic and transient conditions.

* Electrical instruments of indicating the output of detectors are more rapid than mechanical methods. Electrical instruments depends upon the mechanical movement of meter. this cause instrument have limited time response.

* Electronic Instruments are scientific and industrial instruments have very fast response. These instrument have higher sensitivity faster response, greater flexiblity and lower weight or less power consumption.

* Classification of measuring instruments

1) - Absolute or primary
2) - Secondary

* Absolute or primary instruments give the magnitude of a quantity under measurment in terms of physical constants of instrument. Exmples of these instruments are Tangent Galvanometer and Rayleigh's Current Balance.

* Secondary instruments are so constructed that the quantity being measured can only be measured by observing the o/p indicated by the instrument. These instruments are calibrated by comparision with an absolute or another secondary instrument.

Secondary instrument further devided into three catgories. ②

1- Indicating Instruments

2- Intégrating Instruments

3- Recording Instruments

Characteristics of instruments - Two types.

①. Static ② Dynamic.

* Accuracy - It is the closeness with which an instrument reading approaches the true value of the quantity being measured.

* Precision - It is a measure of the reproductibility of the measurment.

* linearity - It defined in terms of independent linearity in most preferable cases. The computition of independent linearity is done with referance to a straight line showing the relation ship b/w output and input.

* Resolution - If the input is slowly increared from some arbitrary (non-zero) input value it will again be found that output does not change at all until a certain increment is exceeded. This increment is called resolution or discrimination of instrument.

* Sensitivity - It is mesurment of change in input respons ratio of magnetude of output signal response.

* Error in mesurment - Any mesurment cannot be mesured with the perfect accuracy. Different types of error occured during measurment. Three types of errors are generated in a instrument.

1)- Gross Errors

2)- Systematic Errors

3)- Random Errors.

* Gross Errors - mainly overcomes human mistakes in reading instruments and recording and calculating measurment results.

* Systematic Errors - these error further devided into three parts. 1)- Instrumental 2)- Environmental 3)- Observational

* Instrumental Errors arise due to these reasons.
  * Due to inherant shortcommings in the instrument
  * Due to misuse of the instrument
  * Due to loading effect of instrument.

* Environmental Error - Effects of temperature, pressure, humidity, dust and vibration or of external magnetic or electrostatic fields.

* Observational Error - There are many source of observational errors. Parallax is main part of such error.

* Loading Effect - The ideal situation in a measurment system is that when an element used for any purpose may be for signal sensing conditioning transmission or detection is introduced into the system the original signal should remain un-distorted. This means that the orginal signal should not be distroted in any form by the introduction of any element in the measurment system.

Topic - CRO

* Introduction.
* CRT Constn & working
* Block diagram of CRO
* Different types.

* Introduction -

* CRO stands for Cathode Ray Oscilloscope.
* Very useful and versatile laboratory instrument.
* Used for display waves, signals, measurment of waveforms.
* Also known as X - Y plotter.
* Avalable in different frequ. ranges from 0Hz to Several GHz.

* CRT (Cathode Ray Tube) -

* CRT Stands for Cathode ray tube.
* CRT is the heart of a CRO.
* Three main parts of CRT are

(I). Electron Gun Assembly (II) Deflection plate Assembley

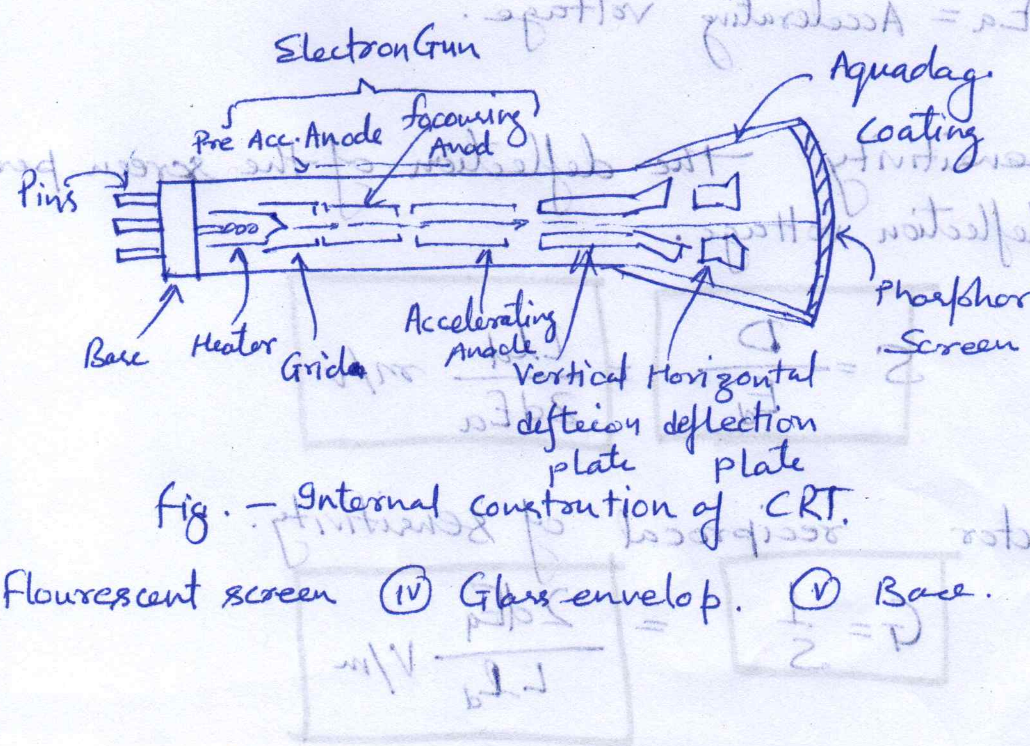


fig. - Internal constrution of CRT.

(III). Flourescent screen (IV) Glass envelop. (V) Base.

* Electron gun assembely produce a sharply focused beam of electrons
* This focused beam of electrons strikes the floursent screen with sufficient energy to cause a luminanous spot on the screen.

* Deflection plate controlls the electron beam.

* The working parts of a CRT are enclosed in an evacuted glass envelop.

* Electron Gun is the source of focused and accelerated electrons.

* Current & voltage required for heter is 600 mA at 6.3 V.
* for High efficiency 300 mA at 6.3 V.

* Deflection D is calculated as

$$D = \frac{L l_d E_d}{2 d E_a}$$

where L = dist^n b/w screen and the center of the deflecting plate
l_d = length of the deflecting plates. in m
E_d = potential b/w deflecting plates in V.
d = distance b/w deflecting plates, in m.
E_a = Accelerating voltage.

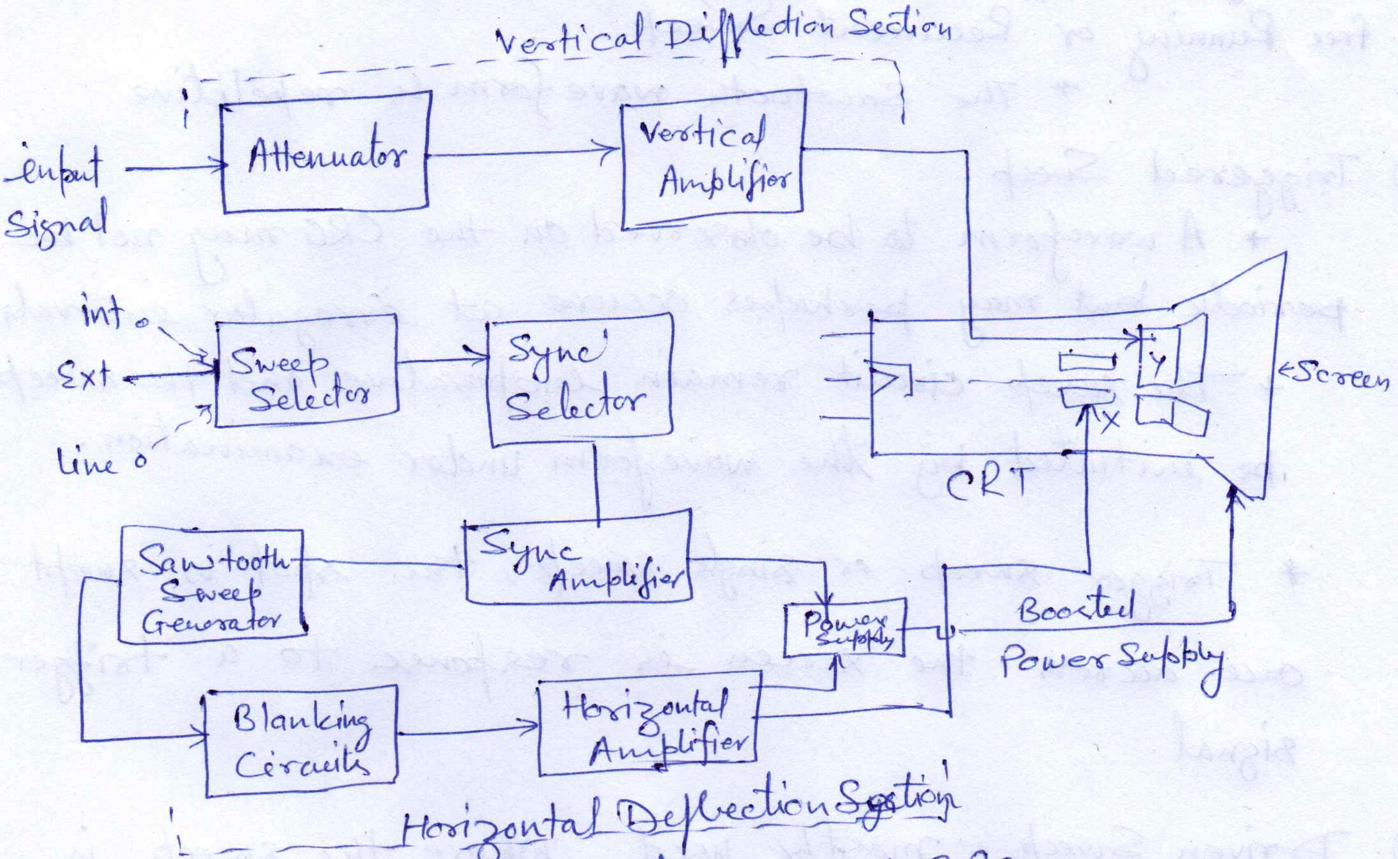
* Deflection Sensitivity. The deflection of the screen per unit deflection voltage.

$$S = \frac{D}{E_d} = \frac{L l_d}{2 d E_a} \ m/V$$

* Deflection factor reciprocal of sensitivity.

$$G = \frac{1}{S} = \frac{2 d E_a}{L l_d} \ V/m$$

CRO - (Block Diagram)



Block diagram of CRO

* Vertical Amplifier -

  * The signals to be examined are usually applied to the vertical or Y deflection plates through attenuator and no. of amplifier stages.

  * Vertical amplifier is required because the signal are not strong enough to produce measurable deflection on the CRT screen.

* Horizontal Deflection Section -

  * These signals are fed by sweep voltage that provides a time base.

  * The horizontal plates are supplied through an amplifier but they can be fed directly when voltages are of sufficient magnitude.

* Types of Sweeps - Four basic types of sweeps.

(1). free Running or Recurrent Sweep.

* The Sawtooth waveform is repetitive

(2) Triggered Sweep.

* A waveform to be observed on the CRO may not be periodic but may perhapes occure at irregular intervals.

* The sweep circuit remain inoperative and the sweep be initiated by the waveform under examination.

* Trigger sweep or single sweep, the spot is swept once accross the screen in response to a trigger signal.

(3). Driven Sweep mostly used where the sweep is recurrent but triggered by the signal under test.

(4) Non Saw tooth Sweep. used for comparision of two frequencies for finding phase shift b/w two voltages.

* Synchronization - used for stationary pattern. This required that the time base be operated at a submultiple frequeny of the signal under mesurment.

* Three methode used for synchronization internal, External and Line methode.

CRO Specifications -

* Specifications of CRO are -

* Screen type - In lab different types of screen used. it is Classification of phosphor. represent florence phosphorance and persistance. P43 is generally used in Lab.

* Total Accelerating voltage - ≈ 2KV used in pre accelerating & focusing anode voltage.

* Vertical Amplifier -
  Bandwidth - DC = 0 - 10 Hz
  AC = 10 - 20 MHz
  At these frequency ranges CRO provides satisfactory results.

* Vertical Deflection - 2m/Div to 10 V/div in 12 Calibrated Steps (1 div = 1 cm)

* Accuracy - ± 5%.

* Input Impedance - 1 MΩ

* Max Rated input voltage - 400 V (dc + ac peak)

* Time base (Time Coefficients) - 0.2 s/div to 0.5 μs/div in 9 calibrated Steps.

* Trigger Source - Int, Ext, line, TV

* Sensitivity - int: 0.75 div, Ext: 0.75 div] trigger frequ^n 100 kHz
  1.0 div, 1.0 V] trigger frequency at 20 MHz.

* External X-deflection – DC : DC to 1 MHz
  AC : 10 Hz to 1 MHz

* Power Supply → Normal voltage range 220V ± 10%.
  240 V ± 10%] Internal

  Normal frequency range 50 V ± 5%.

  Power Consumption 30 VA.

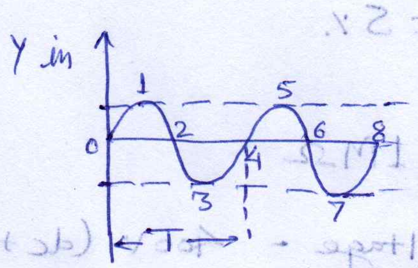
* Length, weight and Size.

These all specifications are 20 MHz Philips CRO.

Model DM 3213.

Different CRO Have different fetaurs.

* Observing Waves On CRO -

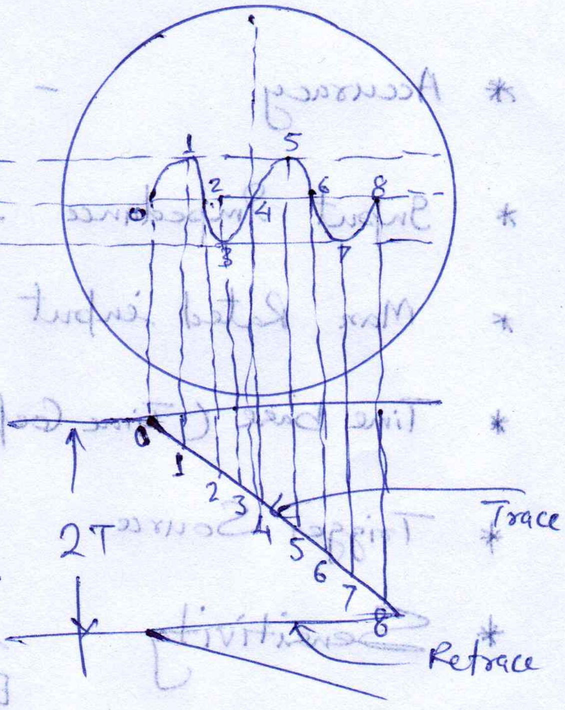


* Input Signal is appleed at vertical plate Y channel.

* Sweep tooth generator signal applied at horizontal plate X-channels.

* Signal divide in multiple division 4, 8, 16, 20, 24 ---

* Match each points and get disired pattern on screen.



Sweep voltage applied to X-plate

CRO Applications -

Three Basic Applications of CRO.

1- Measurment of voltage & Current (AC & DC)

2- Measurment of phase shift

3- Measurment of frequency (Lissajous Patterns)

* for dc measerrment

* DC signal applied at y channel.

* Received deflection on screen is multiplied by deflection sensitivity

* Get the value of DC.

* For AC measerrment

* AC signal applied at y channel

* Switch off the time base switch.

* Screen shows a vertical line. Read this in graticual scale.

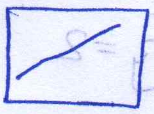
* This line represent peak to peak value of AC

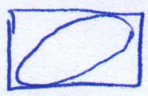
* Meserment of Phase and frequency - (Lissajous Pattern)

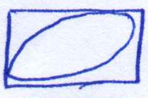
* When sinusoidal voltages are simultaneously applied to horizontal and vertical plates. these patterns are called "Lissajous Patterns."

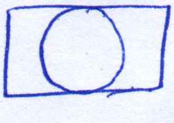
*. When two sinusoidal voltages of equal frequency which are in phase with each other are applied to horizontal and vertical plates the patterns appearing on the screen is a straight line.

$$\sin \phi = \frac{B}{A} \qquad \phi = \sin^{-1} \frac{B}{A}$$

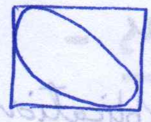
When $\theta = 0°$ or $360°$ Screen appear 

$\theta < 45°$ " 

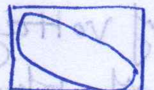
$\theta = 45°$ or $315°$ " 

$\theta = 90°$ or $270°$ " 

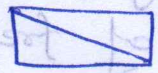
When $\theta = 135°$ or $225°$ Screen will



$\theta < 180°$

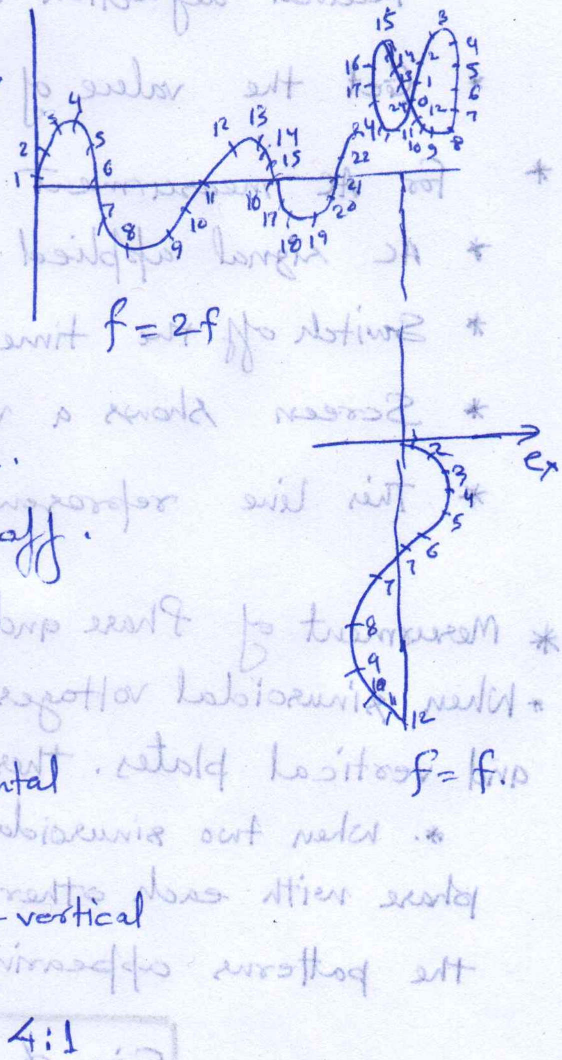


$\theta = 180°$



* Frequency Measurment

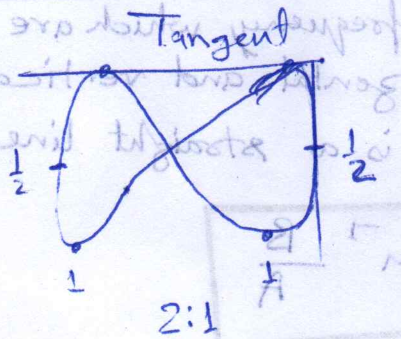
* Lissajous patterns may be used for accurate measurment of frequency

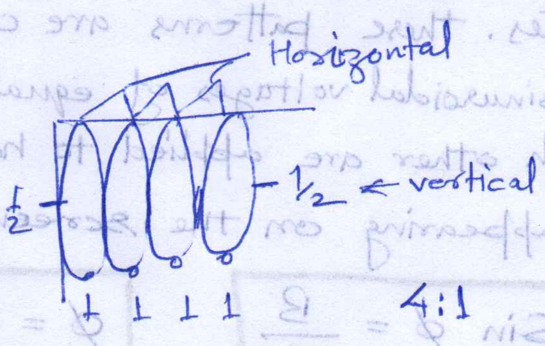


* The signal whose frequeny is to be measured is applied to the Y plates.

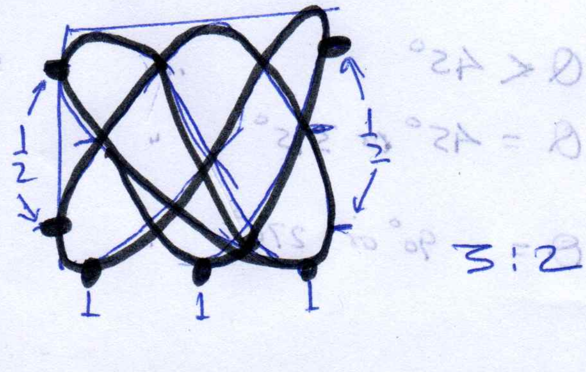
* Accurately calibrated standard Variable frequency applied at X plate. with the internal sweep generator off.

* Screen shows circle or ellips





$f_x = 1$ $f_y = 2$



Topics - 1)- Dual Trace Oscilloscope
2)- Dual Beam
3)- Delayed Sweep
4)- Digital Storage Oscilloscope.

*Dual Trace Oscilloscope

* Block diagram shown the construction of dual trace oscilloscope
* Two vertical channels are used for signal
* Both channel are connected together by a electronic switch.

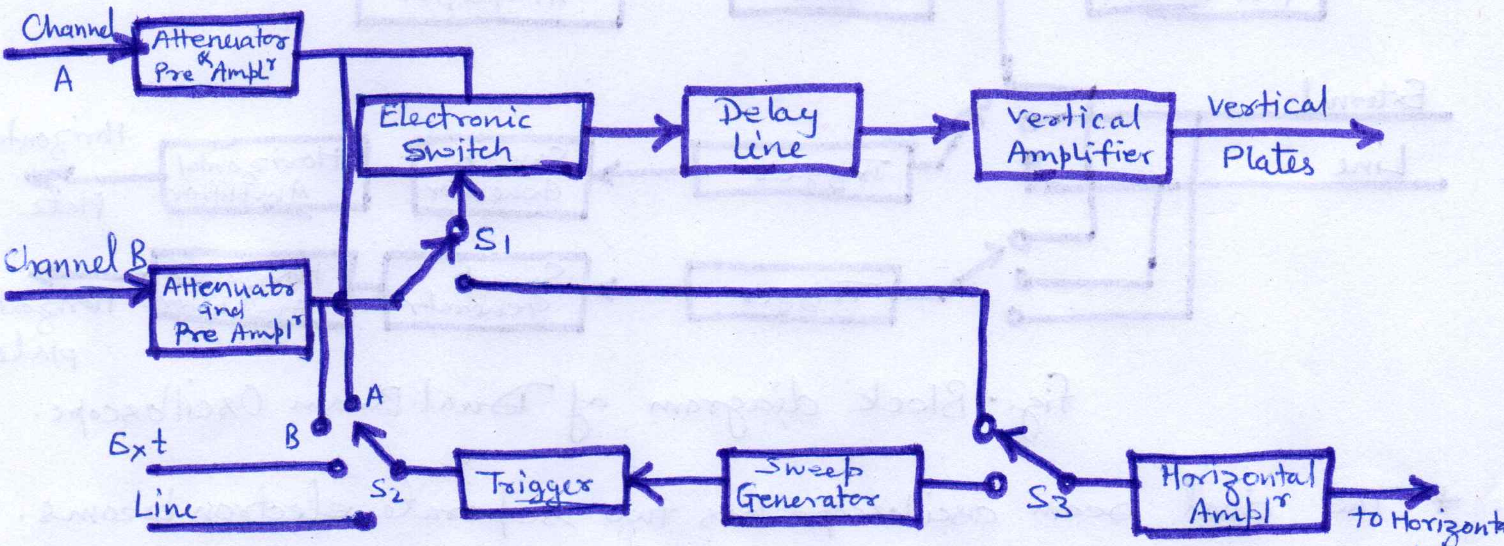


fig:- Block diagram of Dual trace CRO

* This switch has capability to pass one channel at a time into the vertical amplifier.

* Two different mode are used by CRO ① alternate ② chopped mode.

* In alternate mode the electronic switch alternates b/w A and B, letting each through for one cycle of the horizontal sweep.

* The display is blanked during the flyback and hold off periods.

* In chopped mode electronic switch free runs at a high frequ[ency] of order of 100 kHz to 500 kHz.

* The result that a small segment from channel A & B are connected alternately to the vertical amplifier.

Dual Beam Oscilloscope -

* The drawback of dualtrace was it cannot capture two fast transient events as it cannot switch quickly enough b/w traces.

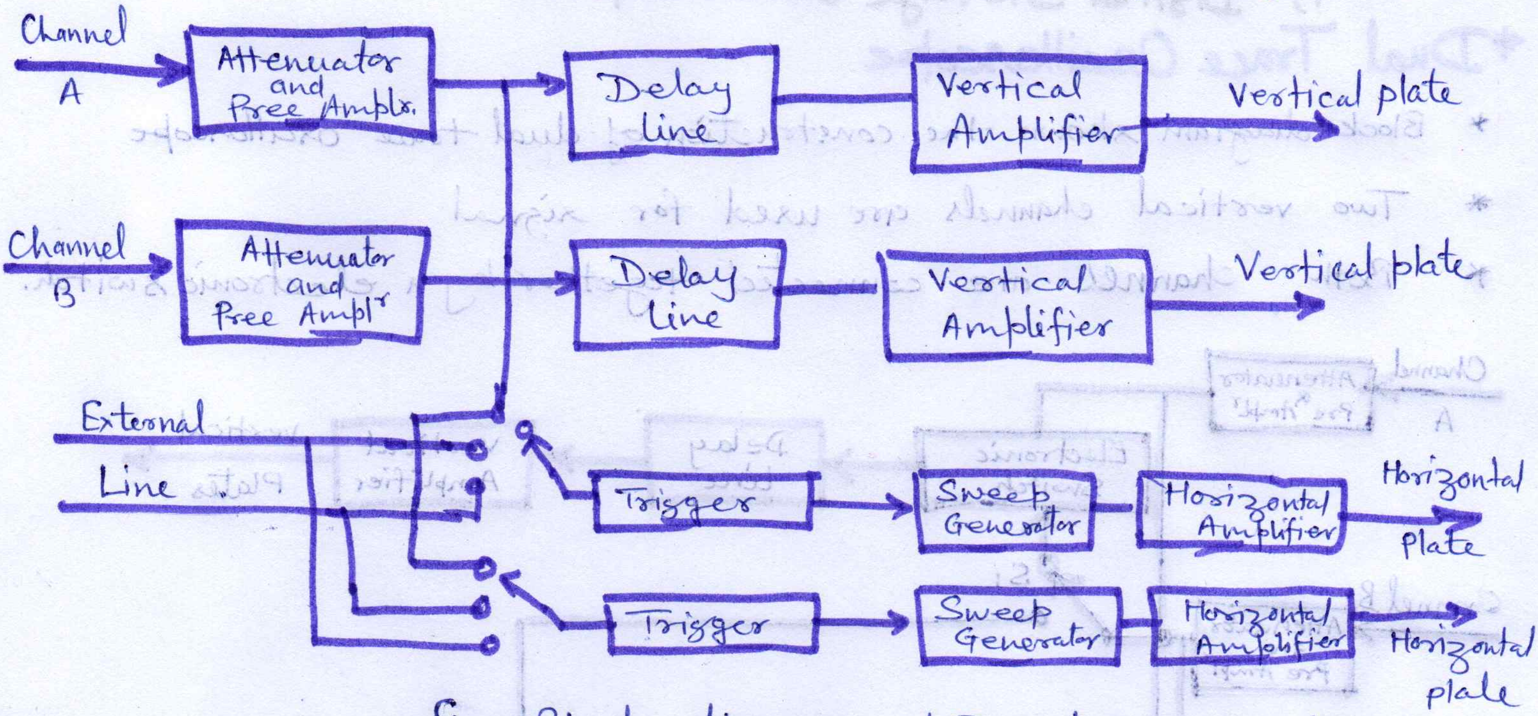


fig. - Block diagram of Dual Beam Oscilloscope.

* The dual beam oscilloscope has two seperate electron beams.
* Two vertical channels seperately.
* Independent time base circuits.
* It increases size and weight of oscilloscope.
* Two methods use for generateng electron beam.
  ① Double Gun ② Splet beam
* At high frequencies these oscilloscope not provide satisfact-ory results.
* The brightness and focus controls also affect the two traces at the same time.

Delayed Sweep – This feature of CRO's increases the versality of the instruments by making it possible to magnify a selected portion of the undelayed sweep, measure waveform jitter or rise time and check pulse time modulation as well as many other applications.

The delayed sweep range from a few μsec to 10 sec. The delayed sweep operation allows the instrument user to view a small segment of waveform – for example an oscillati- or ringing that occurs during a small portion of a lower-frequ- wave form.

* **Digital Storage Oscilloscope** – A digital oscilloscope digiti-ses the input signal so that all subsequent signal are digital. A conventional CRT is used, and storage occurs in electronic digital memory. The input signal is digitised and store in memory in digital form. In this state it is capable of being analysed to produce a varity of different information. To view the display on the CRT the data from memory is reconstructed in analog form.

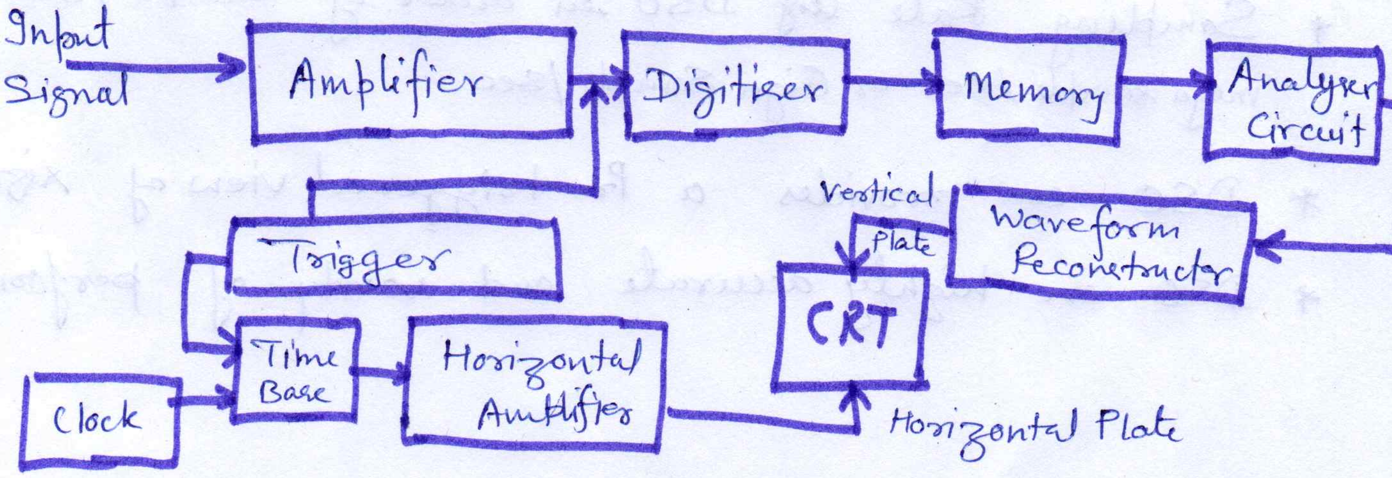


fig. Block diagram of basic DSO

Advance DSO -

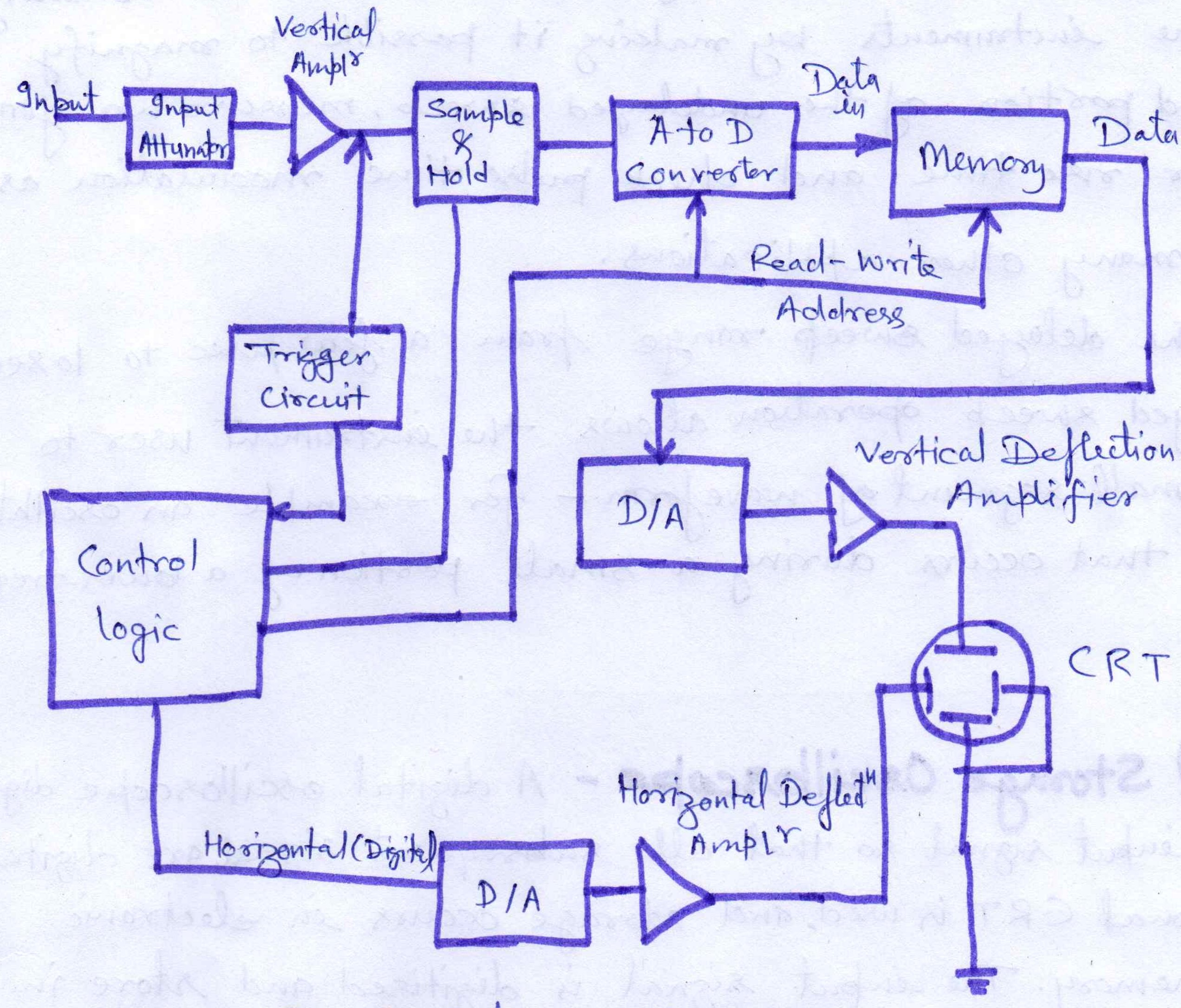


fig. Block diagram of Advance DSO

* The DSO can process by PC or high speed processor.
* It can store data or signal for infinite time.
* All input data converted into digital form.
* Sampling Rate of DSO in order of sample/sec. mega sample/sec or Giga Sample/sec.
* DSO can provides a Pre triggered view of signal.
* DSO are highly accurate and varity of performance.

Impedance Bridges and Q meters -

Topics - 1) Wheat Stone Bridge
2) - AC Bridges -: Maxwell's induction Bridge, Hay's Bridge, De-Sauty's Bridge, Schering Bridge, Anderson Bridge.
3) - Block diagram discreption of laboratory type RLC bridge Specifications of RLC Bridges.
4) - Block diagram and working principle of Q meter.

* Wheatstone Bridge -

* figure shown a balance wheat stone bridge. all four arms are resistive.

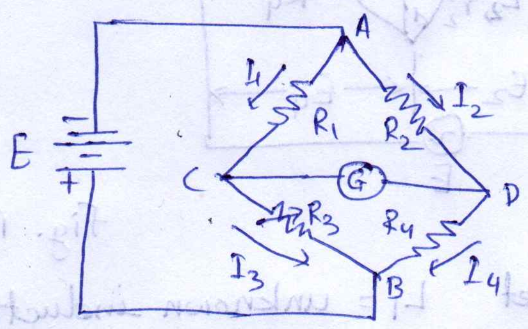


fig: Wheatstone Bridge.

* A null detector galvanometer is used for mesurment of current

* for balance condition.

$$I_1 R_1 = I_2 R_2 \quad \text{—— (I)}$$

If deflection is zero then $I_1 = I_3 = \dfrac{E}{R_1 + R_3}$ —— (II)

and $I_2 = I_4 = \dfrac{E}{R_2 + R_4}$ —— (III)

by solving.

$$\frac{R_1}{R_1 + R_3} = \frac{R_2}{R_2 + R_4} \quad \text{—— (IV)}$$

$$\therefore \boxed{R_1 R_4 = R_2 R_3} \quad \text{—— (V)}$$

If three resistance are known and one unkown the calculate as.

$$\boxed{R_x = R_3 \frac{R_2}{R_4}}$$

R_3 is standard arm and R_2 & R_1 are ratio arm in bridge.

Maxwell's Inductance Bridge - This Bridge circuit measures an inductance by comparision with a variable standard self inductance. The connection and the phasor diagram for balance conditions are shown in fig.

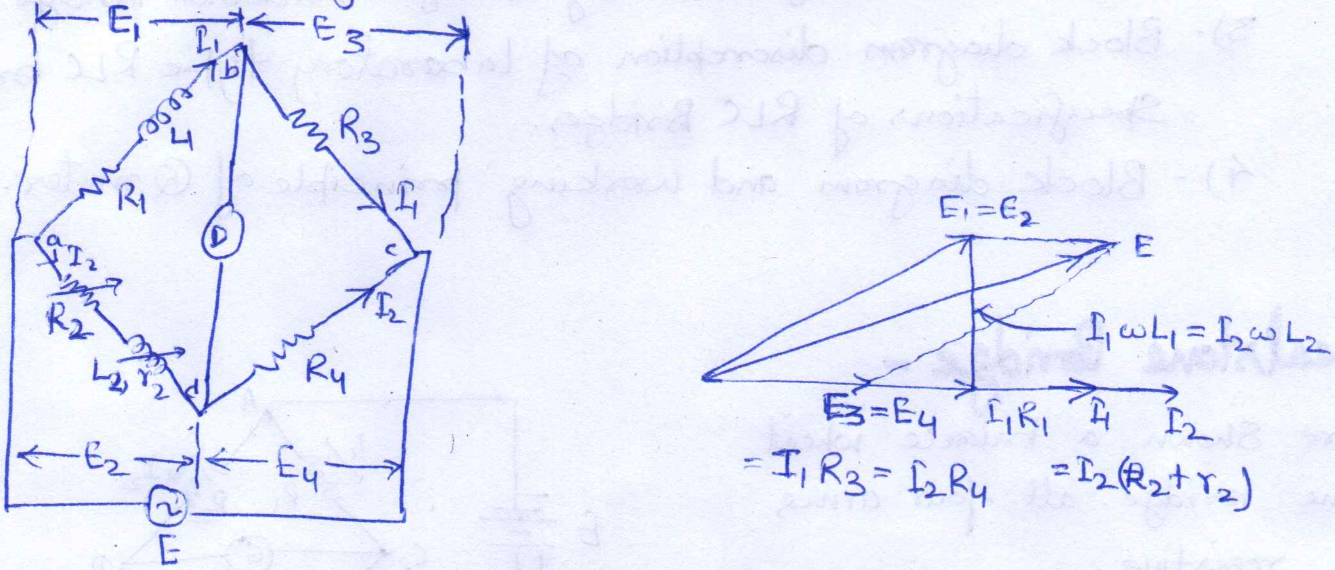


fig. Maxwell's Inductance Bridge.

Let L_1 = unknown inductance of resistance R_1

L_2 = Variable inductance of fixed resistance r_2.

R_2 = Variable resistance connected in series with inductor L_2.

R_3, R_4 = known non-inductive resistances.

At balance $Z_1 Z_4 = Z_2 Z_3$

$L = j\omega L$ or $(R_1 + j\omega L) R_4 = (R_2 + j\omega L_2) R_3$

$$R_1 R_4 = R_2 R_3 \quad \text{or} \quad R_1 = \frac{R_3}{R_4} * R_2 \quad \text{— (I)}$$

$$j\omega L_1 R_4 = j\omega L_2 R_3 \quad \text{or} \quad L_1 = \frac{R_3}{R_4} L_2 \quad \text{— (II)}$$

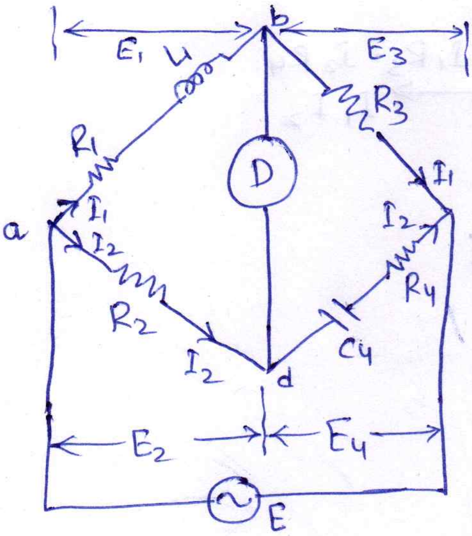
$$L_1 = \frac{R_3}{R_4} L_2 \quad \text{— (III)}$$

$$R_1 = \frac{R_3}{R_4} (R_2 + r_2) \quad \text{— (IV)}$$

The value of R_3 and R_4 from 10, 100, 1000, 10,000 Ω.

r_2 is a decade resistance box.

Hay Bridges – The Hay's bridge is a modification of Maxwell's bridge. This bridge uses a resistance in series with the standard capacitor.



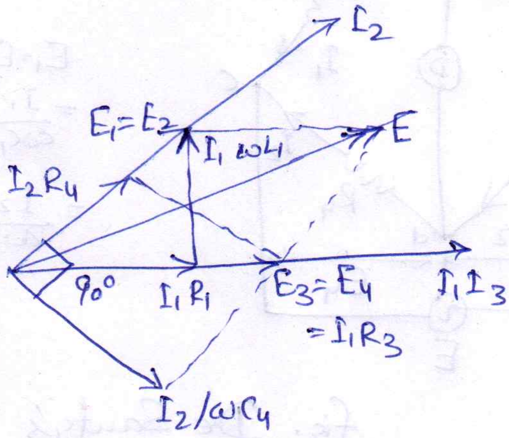


fig. Hay's Bridge.

let L_1 = unknown inductance having a resistance of R_1.

R_2, R_3, R_4 = Known non-inductive resistance

and C_4 = standard capacitor.

At balance $R_1 R_4 = R_2 R_3$ or $Z_1 Z_4 = Z_2 Z_3$

$$(R_1 + j\omega L_1)(R_4 - j/\omega C_4) = R_2 R_3$$

or $$R_1 R_4 + \frac{L_1}{C_4} + j\omega L_1 R_4 - \frac{jR_1}{\omega C_4} = R_2 R_3$$

Seperating the real and imaginary terms.

$$R_1 R_4 + \frac{L_1}{C_4} = R_2 R_3$$

$$L_1 = \frac{R_1}{\omega^2 R_4 C_4}$$

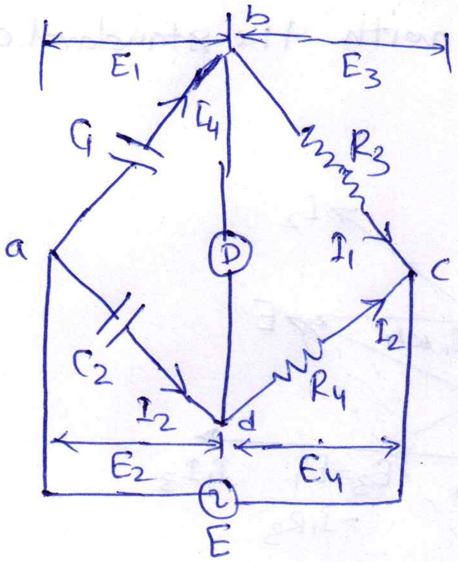
By solving

$$L_1 = \frac{R_2 R_3 R_4}{1 + \omega^2 C_4^2 R_4^2} \quad \text{(I)}$$

$$R_1 = \frac{\omega^2 R_2 R_3 R_4 C_4^2}{1 + \omega^2 R_4^2 C_4^2} \quad \text{(II)}$$

Q factor of coil is $Q = \frac{\omega L_1}{R_1} = \frac{1}{\omega C_4 R_4}$

De Sauty's Bridge - This bridge is used for comparing two capacitors



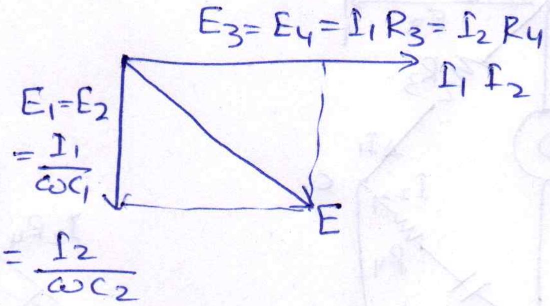


fig. De Sauty's Bridge.

let

C_1 = Capacitor whose capacitance is to be measured

C_2 = a standard capacitor

$R_3 R_4$ = non-inductive resistors

$$\left(\frac{1}{j\omega C_1}\right) R_4 = \left(\frac{1}{j\omega C_2}\right) R_3$$

$$\boxed{C_1 = C_2 R_4 / R_3}$$

The balance can be obtained by varying R_3 or R_4.

* Schering Bridge -

let C_1 = Capacitor whose capacitance is to be determined.

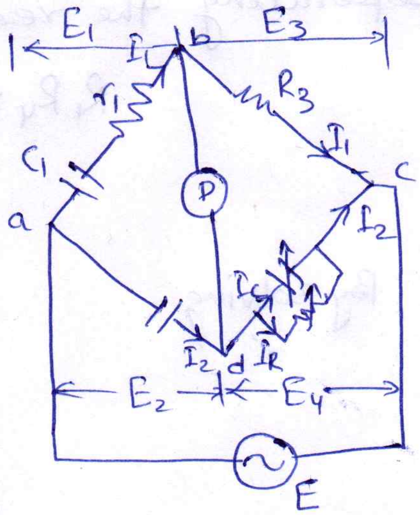
r_1 = a series resistance

C_2 = standard capacitor.

R_3 = non-inductive resth

C_4 = variable capacitor

R_4 = a variable non-inductive resistance || with C_4.



Schering Bridge -

At Balance $\left(r_1 + \frac{1}{j\omega C_1}\right)\left(\frac{R_4}{1 + j\omega C_4 R_4}\right) = \frac{1}{j\omega C_2} R_3$

$$\left(r_1 + \frac{1}{j\omega C_1}\right) R_4 = \frac{R_3}{j\omega C_2}(1 + j\omega C_4 R_4)$$

$$r_1 R_4 - \frac{j R_4}{\omega C_1} = -j\frac{R_3}{\omega C_2} + \frac{R_3 R_4 C_4}{C_2}$$

Equating real & imaginary terms

$$r_1 = R_3 C_4 / C_2 \quad \text{—— (i)}$$

$$C_1 = C_2 (R_4 / R_3) \quad \text{—— (ii)}$$

Andersson Bridge - In this method the self-inductance is measured in terms of a standard capacitor.

let L_1 = self inductance to be measurred

R_1 = resistance of self inductance

r_1 = restⁿ connected in series with self inductor.

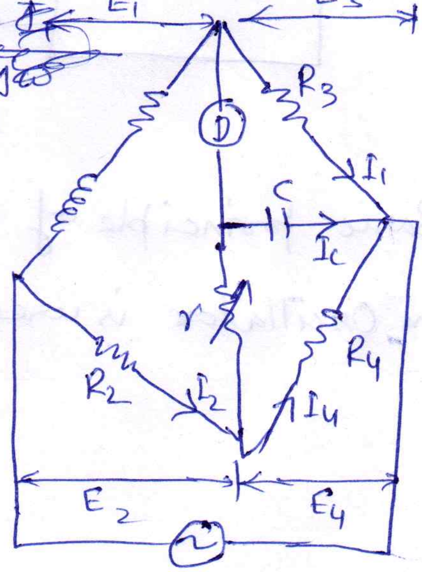
r, R_2, R_3, R_4 = known non-inductive resistance.

C = fixed capaciter

$$I_1 = I_3 \quad \text{or} \quad I_2 = I_c + I_4$$

$$I_1 R_3 = I_c \times \frac{1}{j\omega C}$$

$$I_c = I_1 j\omega C R_3$$



$$I_1(r_1 + R_1 + j\omega L_1) = I_2 R_2 + I_c r$$

or $$I_c\left(r + \frac{1}{j\omega C}\right) = (I_2 - I_c) R_4$$

Substituting the value of I_c in above equⁿ we get.

$$R_1 = \frac{R_2 R_3}{R_4} - r_1 \quad \text{—— (i)}$$

$$L_1 = C\frac{R_3}{R_4}[r(R_4 + R_2) + R_2 R_4] \quad \text{—— (ii)}$$

* LCR Bridge

LCR bridge is used for measurment of unknown resistance, capacitance and inductance.

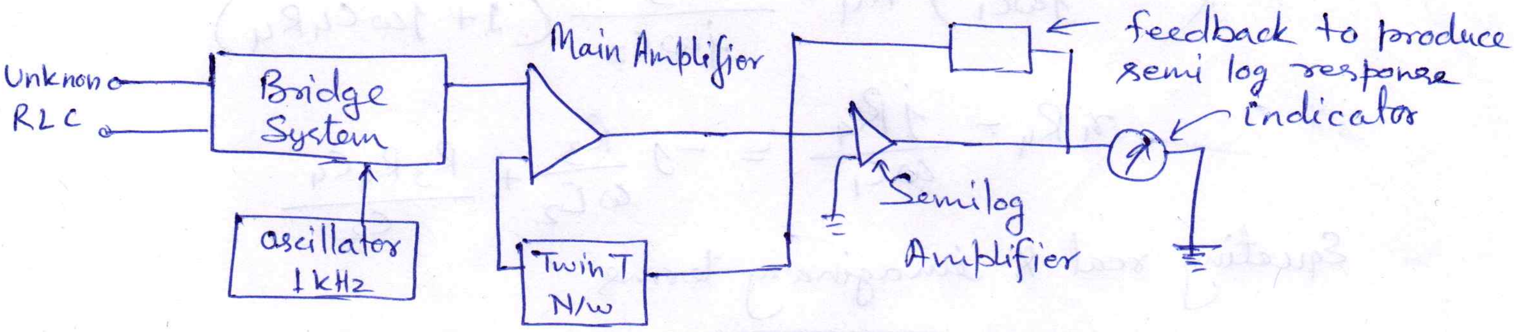
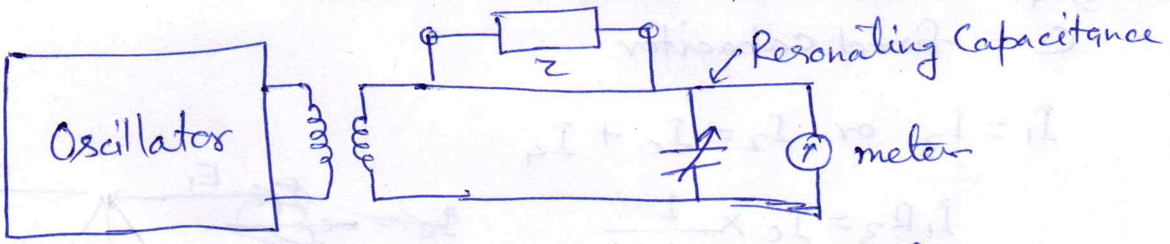


fig. – Balancing Type LCR Bridge

* Bridge System – for measuring unknown components use seperate bridge for R L and C. These bridges are selected by push button switches.

* Q-meter

Also known as storage factor $Q = \frac{\omega_0 L}{R}$ where ω_0 is resonance frequency, L is inductance R is effective resistance.



Block diagram of Q meter

* Basic principle of Q-meter is RLC series resonance circuit.
* An Oscillator is used for generating frequcy 50 kHz to 50 MHz.

Digital Instruments -

Topics - 1) - Comparision of analog & digital instruments
2) - working principle of ramp, dualslope and integration type voltm
3). Block diagrams.
4). Time interval, time period, frequency interval, counter
5). Logic probe, pulser, analyzer, comparator, signature analy

* Introduction -

The digital technique used in industrial/Electronic instrumentation enrich the user with high accuracy. (±5% to ±0.05% of range of measurme Digital system provides high input impedance (~2MΩ) to ensur less loading effect on the input circuit. The numerical readout of the digital system allows the worker to perform measurment with zero error unlikeanalog system.

The basic tools for digital systems are-

1. Crystal Oscillator (1MHz) with high temp. stability ($10^{-8}/^{o}C$) Used as the main element in a LC circuit.
2. Decade (Mod 10, Mod 6, Mod 12) Counters
3. AD Converters.
4. Voltage frequency converter for high precision.
5. Phase Lock loop (PLL) is also building blocks of digital instruments.

* In digital measurment all units are converted into small sub unit or divisions known as quanta.

* Accuracy can be increased by increasing number of quanta levels.

Advantages of Digital Instruments-

1- In digital instruments readings are represented in digit
2- Chances of error like human error, or parallax error are decreses or very less.
3- Reading taken in significant figures.
4- Digital instrument directly connected in to computers floppy, Harddisks or other storage devices.
5- Power consumption is very less in digital instrumen

Comparision b/w Analog & Digital Instruments-

Characteristics	Analog Inst^r	Digital Inst^r
1)- Accuracy	Maximum ±0.1% at full scale	Very high.
2). Resolution	One part of in several hundred	One part of in several thousands
3. Power Consumption	More	less
4. Cost	Expensive	Cheeper.
5. Handling	Bulky	Light
6. Circuit	Complex	IC based Simple.
7. Range and Polarity	AC or DC	AC & DC Automatic Polarity
8. Observation error	Parallelax	No or less.
9. Memory	No	Yes
10. Size	large	Small

Ramp type DVM -

* The operating principle of a ramp type digital voltmeter is to measure the time that a linear ramp voltage takes to change from level of input voltage to zero or voltage.

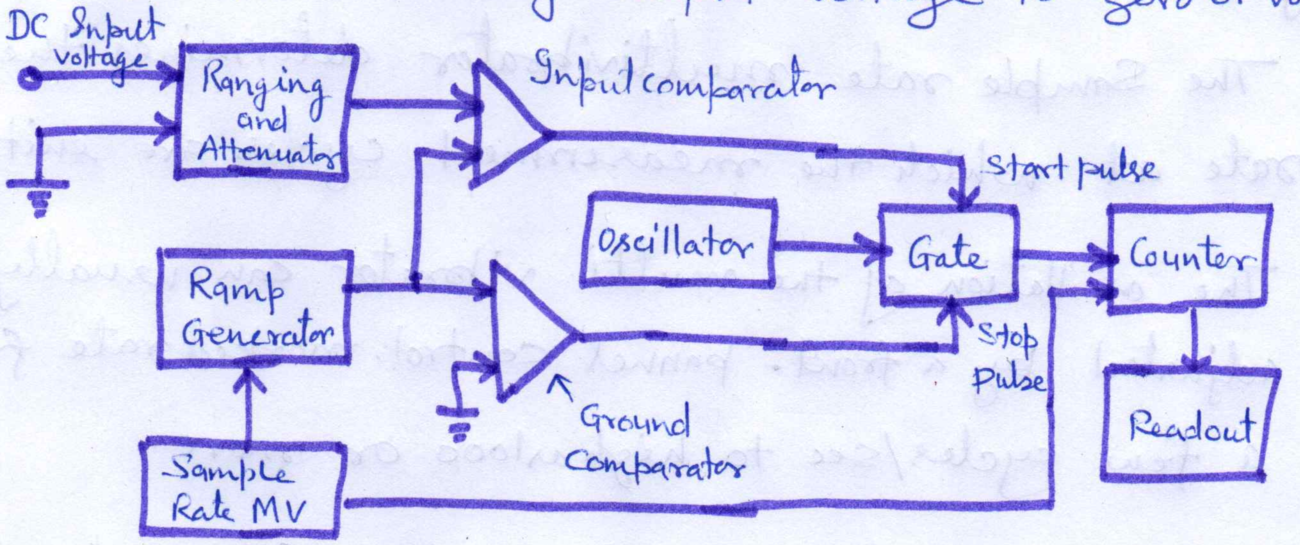
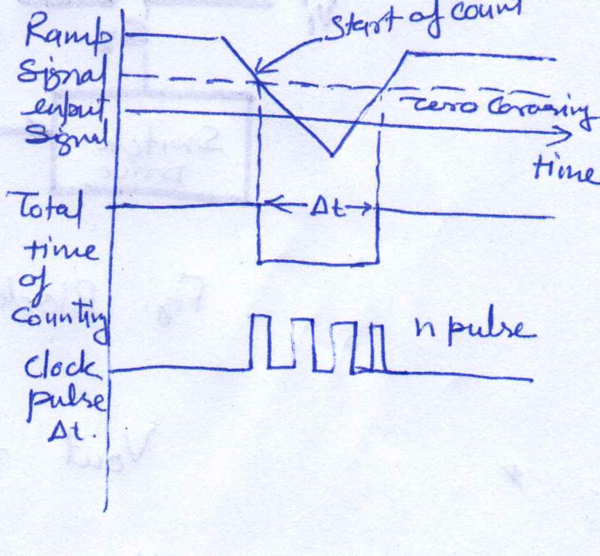


Fig. Ramp type Digital voltmeter Block diagram.

* The time interval is measured with an electronic time interval counter and the o/p count is displayed as a number of the digits on electronic indicated tube of the output readout of the voltmeter.

* The conversion of a voltage value of a time interval.

* At start of the mearurment cycle a ramp voltage is initialed, the voltage can be +ve going or -ve going.



* fig shown continuously compared with the unknown input voltage.

* At the instant that the ramp voltage equal the unknown voltage

* An Oscillator generates the clock pulses which are allowed to pass through the gate to a number of decade counting which totalized the no. of pulses passed through the gate.

* The Sample rate multivibrator determines the rate at which the measurement cycles are initiated.

* The oscillation of the multi vibrator can usually be adjusted by a front - pannel control, marked rate from a few cycles/sec to high as 1000 or more.

* The sample rate circuit provides ramp generator to reset ramp voltage.

*** Dual Slop DVM -** Dual Slope DVM integrates the input voltage V_i, the slope of the integrated signal is proportional to the input voltage under measurment.

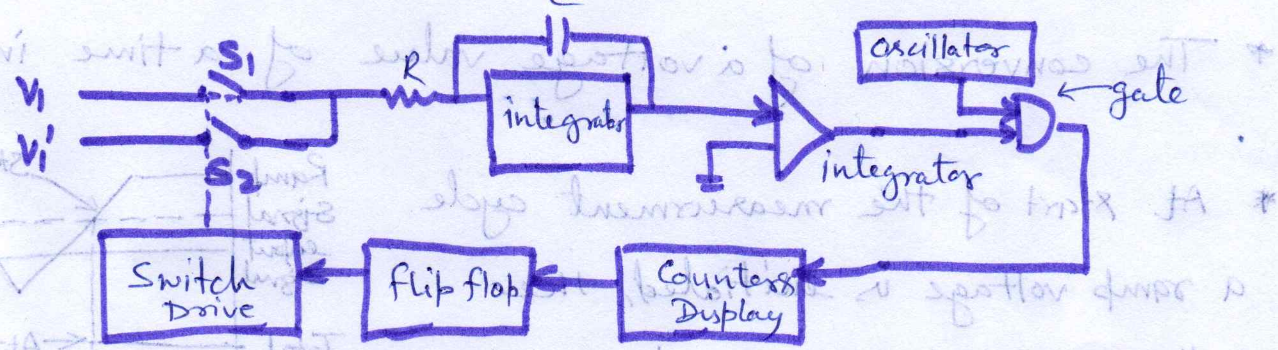


Fig. Block diagram of Dual Slop DVM

* $$V_{out} = -\frac{V_i t}{RC}$$

output voltage.

* Initially a pulse is applied to reset the counter and the O/P of the flip-flop will be at logic 0.

The switch S_2 is in open condition and the switch S_1 is in closed condition.

* The capacitor starts charge. Once the o/p of the integer becomes greater than zero, the o/p state of the comparator changes which in turn on the AND gate.

* When the gate opens the o/p of the oscillator are allowed to pass through it and applied to the counter.

* As soon as it reaches its maximum count that the counter is preset to run for a time period T_1 in this condition the maximum count will be 9999, and next will be 0000 and the flip flop activated.

Advantages of Dual Slop DVM -

1) - Depending on the requirement the accuracy and speed can be varied.

2) - It can provide the o/p with an accuracy of ± 0.005% in 100 ms

3) Reject noise

* Sensitivity of Digital meters -

$$S = (\text{full scale Value})_{min} \times R$$

S = Sensitivity

R = Resolution

* Instruments for testing Digital Circuits.

For testing digital circuits these instruments are used.

1)- Logic analyzer   2)- Signature Analyzer
3)- Logic Probe   4) - Logic Pulser
5)- Logic comprator   6)- Current Probe.

* Logic Analyzer - It is an electronic instrument that captures and displays multiple signals from a digital System or circuit. it conver input signal into timing diagram. Logic analyzer have advanced triggering capabilities. and are useful when a user needs to see the timing relationship b/w many signals in a digital system.

* Two type of analyzer used   (i)- State logic analyzer
  (ii)- Timing logic analyzer

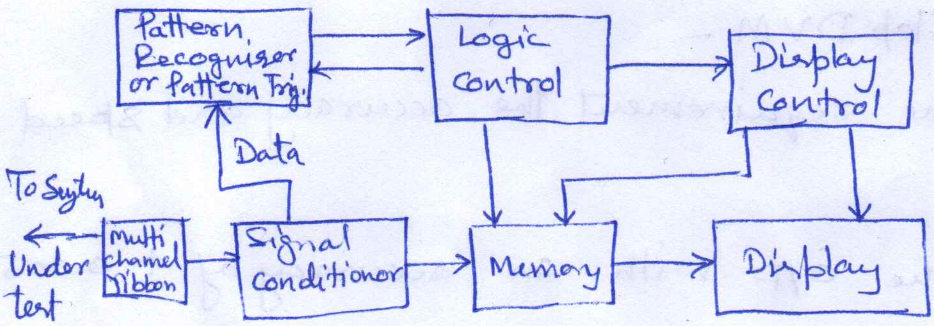
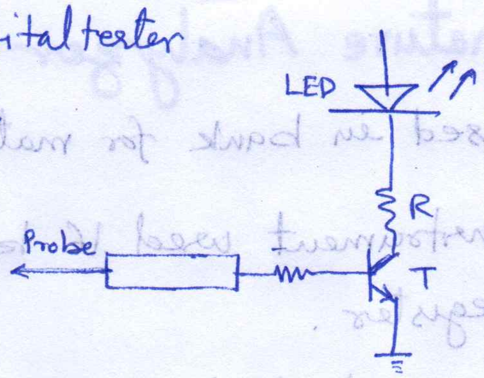


fig. -State logic Analyzer Block diagram

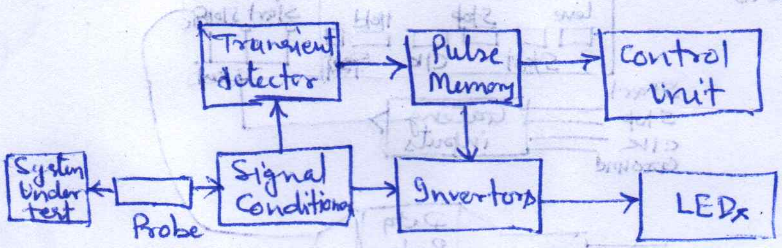
* Logic analyzer simulated to defects before the unit is constructed

* FPGA have become a common measurment point for Logic analyzer and are also used to debug the logic circuits.

Logic Probe – The logic probe or digital tester is normally a low cost handheld probe contained within a pen-like tube with indicator LEDs to shows the state of the line being probed.



Basic logic Probe



Block diagram of logic Probe

* Logic probes are used to test digital circuits like those using TTL or cmos logic.

* Logic probe is normally powered by the circuit under test there are normally leads with crocodial clips that can be attached to the ground and supply of the circuit under test.

* Advantages of logic probe
  1. Low cost
  2. Ease of use.

* Disadvantages of logic probe.
  1. Very rough measurment
  2. Poor display

Signature Analyzer -

* Used in bank for matching sign of consumer.

* Instrument used 16 bit shift register.

* At initial state its value is zero.

* All bit scramble the final signature.

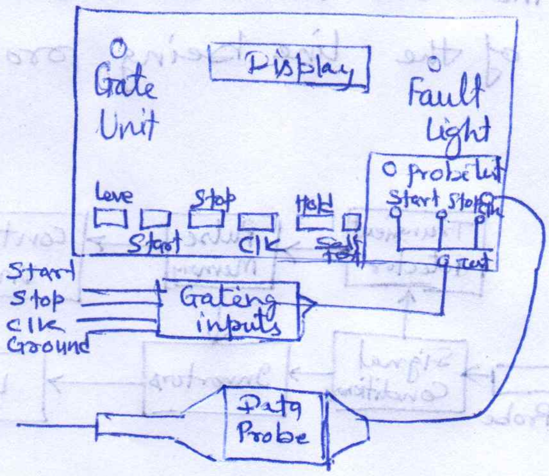


fig. - Signature Analyzer layout

* Normally used for checking data on given nodes within a logic system such as a microprocessor board.

* The basic signature analyzer takes in the input from the node under test and using a clock from the system.

* Start and stop pulses are captured to start and end the sample.

* The pulses from the node under test are then passed into a shift reg. to provide the hexadecimal equivalent of the waveform.

* It used for fault finding, and ascertaing the operation of complex logic boards.

* Typically the operations of the board could be returned to base for a full test, possibly on an automatic functional tester.

Logic Pulser -

* Logic pulser is use for troubleshooting logic circuits.
* It is similar to logic probe.
* It is inject a logic pulse into the circuit under test.
* logic pulser generally used in conjuction with a logic clip or a logic probe to help trace the circuit under test.

Digital Comparator -

* Digital or Binary comparators are made up from standard AND, NOR and NOT or Ex-OR gate. that compares the digital signals present at their input terminals and produce an output depending upon the condition of those inputs.

* Logic comparator compare the faulty IC outputs and compare with referance IC. An Ex-OR gate used for this comparision.

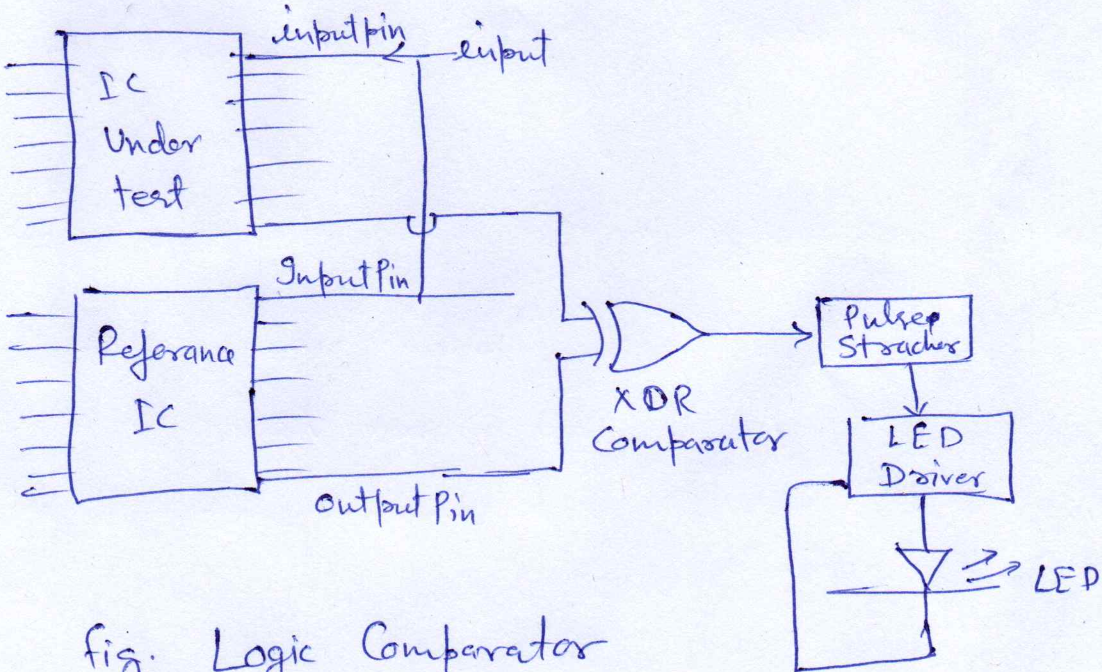


fig. Logic Comparator