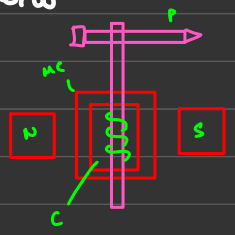
- **PMMC**

Principle : When a current carrying conductor is placed in a mag field, it experiences a force and moves away frm field.

Construction :
i) Two N & S permanent mag
ii) Soft iron core in cylindrical shape b/w
iii) former Aluminium with copper coil
iv) Two helical springs for torque
v) Point attached to spindle



Working :
i) Mag fld is produced by permanent mag
ii) movil coil carries current ∝ voltage measured
iii) EM force act on coil and moves it away frm fld
iv) The movement makes spindle move and point gives ∝ deflection

i) deflecting torque : ∝ current, voltage measured

ii) Control torque : spring control

iii) damping torque : eddy current damping

- **DMC**

Principle : When a current carrying conductor is placed in a mag field, it experiences a force and deflection of conductor takes plac

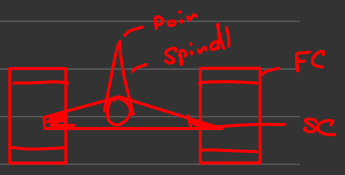
Construction :
i) fixed coil made in 2 sectn with some spac
ii) moving coil placed b/w
iii) The pointer allowed to move
iv) Two helical springs attached to spindle
v) Piston to move inside air chamber

Working : The fixed coil & moving coil carry current, thus mag fld produced and em force on coil moves it away with pointer showing deflection

Deflecting Torque :-

As Voltmeter : Two coils electrically in series
carry current ∝ voltage measured (AC / DC)
deflect T ∝ (Volt)²

As ammeter : "
carry current to measure
deflect T ∝ (Curr)² (AC / DC)



As Wattmeter : Fixed coils carry curr
Mov coil carry curr ∝ volt
deflect T ∝ VI cos ϕ

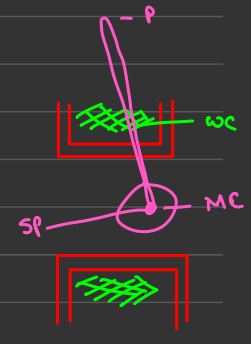
Control T : Spring
Damping T : Air Damping

- **AMI (Attraction Type)**

Principle : Soft iron core is brough near the ends of a coil carrying I. Iron is attracted where magnetic flux density is more. Movement is used to measure I / V that produces $\vec{B}$.

Construction : i) WC (working coil) carries I ∝ V
ii) Soft iron disc attached to pointer
iii) MI is pivoted so that it is attracted towards centre of coil ($\vec{B}$ is max)

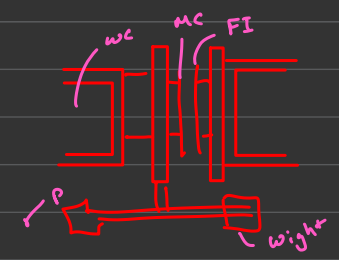
Working : WC coil carries I that produces $\vec{B}$
MI attracted towards centre (flux max)
Spindle moves, pointer gives deflection



Deflecting Torque : ∝ I^2 / V^2
Control Torque : spring / gravity
Damping : Air friction damping

- **Repulsion Type**

Principle : 2 iron pieces kept close in a $\vec{B}$ gets magnetized to the same polarity. A repulsive force is produced. If one piece is movable, due to the force it will move to one side. This movement will measure I/V



Construction : i) MC carries $I \propto V$
ii) 2 iron pieces (fixed & moving)
iii) MI connected to spindle → pointer

Working : i) B is produced that magnetises both soft iron pieces
ii) repelsive force produced that moves the iron from its rest position.
iii) spindle moves & gives deflection

Deflecting Torque : $\propto I^2/V^2$
Control : Spring / gravity
Damping : Pneumatic (air damping)

(MC measures only DC quantities
(MI both AC/DC

- **DMM (Digital Multimeter)**

It contains three different meters in one :-

i) used to measure AC/DC voltages
ii) used to measure AC/DC current & resistance
iii) gives accurate digital output

Parts :-

i) Display : i) illuminated display screen for better visualisation
ii) four digit display
iii) Indicators like AC/DC, etc

ii) Selection knob

iii) Connection ports : i) Three / four ports available
ii) 2 used at a time
iii) Common port : used with all measurements

Measurements :-

In AC Voltage Mode : Input Voltage → Attenuator → full-wave rect → → ripple reduction filter → DC → Analog digital Convertor (ADC) → display screen.

Current :-

DC Mode : drop across shunt is measured directly by ADC

AC mode : After AC → DC conversion , drop is measured by ADC

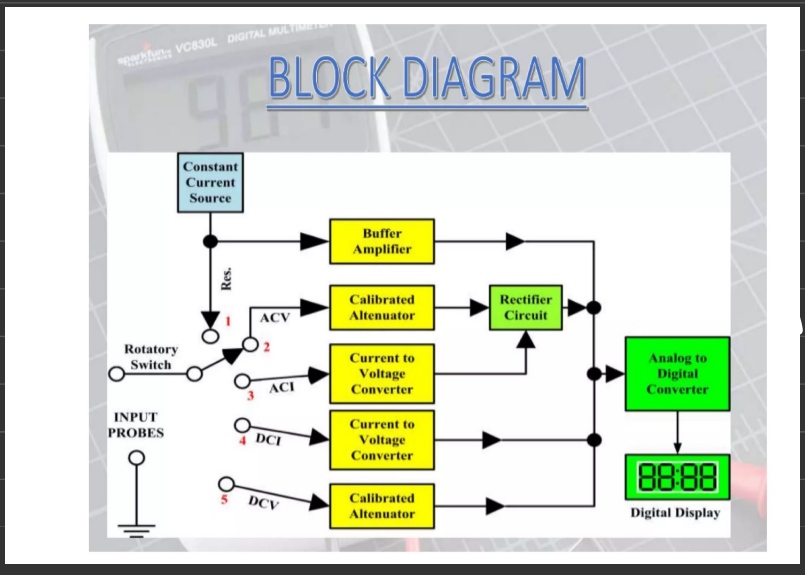
Resistance mode : measures V across externally connected R, resulting frm I flowing thru it.

Special function : i) Continuity tester : checks b/w 2 pts
ii) diode tester : used to check R diode for RB/FB
iii) Battery tester : 9 & 1.5 V

Adv : i) High accuracy
ii) High Input Impedance
iii) Numeric display

Disadv : not good w measurement flucuation
expensive than analog
difficult to find one.

- Block diagram



- **DSO**

Definition : It's an instrument that gives the storage of a digital waveform or digital copy of a waveform

It allows to store the signal in digital format

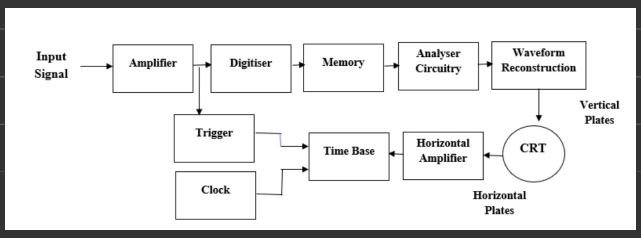
The max^n freq measured on DSU depends on 2 things :
i) sampling rate of scope
ii) Nature of the scope

The Display Trace is bright & shown within seconds

Block diagram xpln :-

- At first the DSO get the analog input signal
- The signal is amplified by amplifier if weak
- The amplified signal is digitized by digitizer & stored in memory
- The analyzer circuit process this digital form
- The waveform is reconstructed (digital → analog)
- Signal is applied to Vertical plates of CRT
- CRT has 2 inputs :-
  Vertical input - Y axis
  Hori - X axis
- The time base circuit is triggered by :-
  i) trigger
  ii) clock input
- It generates time base (ramp) signal
- Ramp ampli by Horiz. ampli
- Then applied to CRT
- we'll get waveform on screen

- Input taken at periodic intervals
- i.e after half-cycle complete
- Digitization follows sampling thm :-
  sample input rate > 2 (freq of input signal)
- If analog → digi x = aliasing effect.



DSO operation modes

i) Roll mode : very fast varying signals are made
ii) Store mode: signal stored in memory
iii) Hold / Save mode: some part on hold, rest stored in memory.

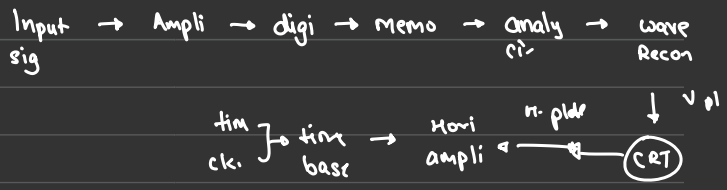
Waveform :

linear : dots joined by st lin 

Sinusoidal : by sine wave 

Application : i) used in med field
ii) research
iii) analyse TV waveforms
iv) designing

Adv : portable
high speed
high bandwidth



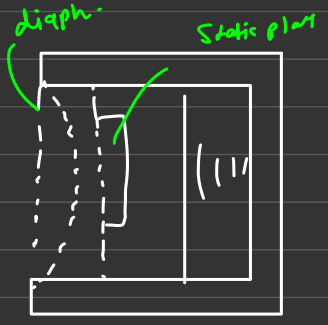
Disadv : high cost
complex

- **Capacitive Transducer**

$$C = \varepsilon_0 \varepsilon_r \frac{A}{d}$$

(ε_r: rel per; A: area; d: dist b/w 2 plates; ε_0: dielt const)

$$C \propto \frac{A}{d}$$



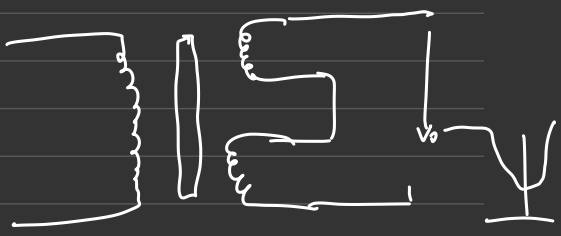
Working : i) When force applied to diaphragm
ii) dist b/w diap & static plate changes
iii) Change in C is measured by ac bridge / oscillator circuit
iv) Can measure static & dynamic changes

- LVDT (Linear variable differential Transformer)

Construction: i) primary coil & 2 similar secondary coils
ii) Rod shaped Magnetic core is in the centre of the coil.

Working: i) AC current in fed in primary coil
ii) V_{o1} & V_{o2} Volts in secondary coils
iii) Coils connected in series
iv) $V_{output} = V_{o1} - V_{o2}$
v) If core at centre, $V_{o1} = V_{o2}$, $V_{output} = 0$
vi) V_{output} is produced by displacing the core
vii) V phase changes by 2π as core moves thru central position

Adv: i) High range
ii) low hysteresis
iii) light weigh
iv) low power consumption



Disadv: i) Temp affects performance
ii) Sensitive to stray mag fild

Uses: i) used everywhere displacement range from mm to cm
ii) measure weight, force, pressure

~~Prox~~ sen
IR ~~sens~~
~~Pressure~~ sens
Bio sens
Smart bldg

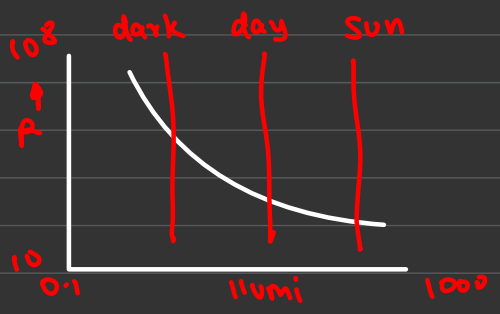
- **LDR / photocell / photo-resistor**

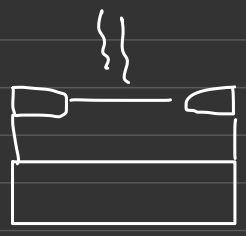
Sensitive to light, when light falls on it, resistance decreases.
It works under several megaohms in darkness and fall to hundred ohms

Made from led, Cadmium Sulphide, PbS, etc

Working : i) semicon with high resistance
ii) few free e⁻s move, rest locked in crystal structure
iii) light falls, photons absorbed by semicon
iv) energy transfer to e⁻s & they break free & conduct elec
v) Thus, resistance ↓

Characteristics : If kept in dark, R ↑↑ and called dark resistance





Structure. i) semicon region deposited on insulating substrate
ii) active region lightly doped
iii) more area exposed to light

Types: i) Int LDR : undoped semicon, basic principle

ii) Ext LDR : less energy to e⁻ to conduct due to doping so easily R ↓

Applications: i) Alarm Clocks
ii) Burglar alarm
iii) Street light design
iv) detect absence / presence of light

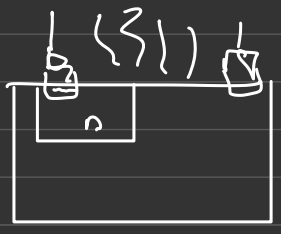
- **Photodiodes**

Converts light energy into elec energy.
works opp of LEDs
It's a P-N Junction diode made of Si, Ge, In, etc
produces current

Working: i) Light falls on semicon
ii) $E \geq Eg$, e-h pair generate
iii) seperated by elc fld
iv) e^- go to n-side with fld
v) holes to p-side

Apps: i) used in solar cell panels
ii) used in logic circuits
iii) used in detection circuit
iv) provide elec. isolation with optocoupler
v) faster & complex than other PN

- **Phototransistors**



It changes energy of light to electrical energy
Detect light pulse & convert to elec signals
produce both curr & volt
made of bipolar semicon NPN / PNP

Construction: i) bi-polar transistor NPN / PNP
ii) Mostly common-emmitor config used
iii) Made of Ga-As for high eff
iv) Base is lead
iv) emittore (-ve), base (+ve)

Working: i) when no light, current is due to thurmally generated e-h pairs
ii) light falls on CB junc, curr flow inc, goes to BE junc
iii) CB is very sensitive
iv) The photons r amplified resulting in current gain

Apps : i) Security system
ii) Puch-card reader
iii) Counting systems
iv) elec controls

Photodiode	Phototransistor
The photodiode is a PN-junction diode, used to generate electric current once a photon of light strikes on their surface.	The phototransistor is used to change the energy of the light into an electrical energy
It is less sensitive	It is more sensitive
The output response of photodiode is fast	The output response of the phototransistor is low
It produces current	It produces voltage and current
It is used in solar power generation, detecting UV otherwise IR rays & also for light measuring, etc.	It is used in compact disc players, smoke detectors, lasers, invisible light receivers, etc.
It is more reactive to incident lights	It is less reactive
The photodiode has a less dark current In this, both the biasing is used like forward and reverse	Phototransistor has high dark current In this, forward biasing is used
The linear response range of photodiode is much wider	The linear response range of phototransistor is much lower
Photodiode allows low current as compared to a phototransistor	Phototransistor allows high current as compared to the photodiode
The photodiode is used for battery-powered devices that use less power.	The phototransistor is used as a solid-state switch, not like a photodiode.

- OptoCoupler

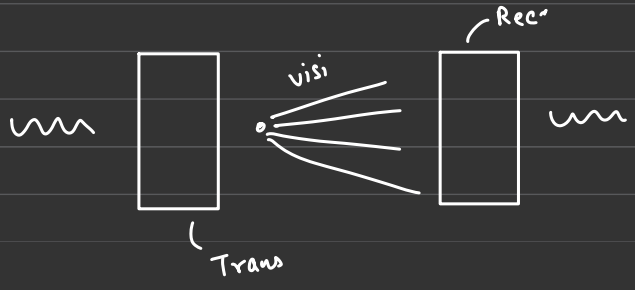
OptoCoupler (opto-isolater / photocoupler / optical isolater)
Transfers elec signals b/w two isolated circuits using light

Two parts :

LED : detect ligh
photosensitive device : detects light from LED

(Both contained within a black box

Working: i) photosensor is the output circuit that detects light
ii) Output will ↓ AC/DC
iii) Curr applied to optocoupler
iv) LED emit IR light ∝ curr
v) curr goes to led , IR beam cuts



Types: i) Photo-transistor & Photo-darlington - DC
ii) Photo-SCR & Photo-TRIAC — AC

Adv: i) provide elec isolation
ii) small size
iii) light weight

disadv: i) operational speed low
ii) for high P, signal coupling may arise

Apps: i) used in high power inverters
ii) high power choppers
iii) AC - DC convertor

- LCD (Light Crystal Display)

Uses light-modulating properties of liquid crystal with polarizers
Does not emit light directly, use backligh / reflector
Arbitary images are made by small pixels.

Construction: i) 2 polarized glass pieces filter
ii) The glass which does not have film on its surface should be rubbed by a polymer to creak microscopic grooves
iii) Add a coating of pneumatic liquid crystal on one of the films.
iv) light travels frm layer to layer with a molecule with vibrations

Working: i) when elec curr applied, the molecule untwists
ii) This causes change in angle of the Top polarizing filter
iii) This process goes frm layer to layer
iv) when no current, the light passes thru LCD and reflected back by the mirror

Adv : i) consumes less power
ii) low cost
iii) provide best contrast

Disadv : i) slow speed
ii) low reliability
iii) needs AC drive

Apps : i) LCD televisions
ii) In DVD players, video games
iii) In Clocks
iv) Replaced by OLEDs

- **Proximity Sensor**

Able to detect the presence of nearby objects without any physical contact

Emits an EM radiation and looks changes in the envo

Types:-

i) Inductive proximity sensors

Detect Mag loss due to eddy current that are generated on a conductive surface by ext mag. fld

Also, Aluminium-detecting sensors detect phase component of freq
Pulse response sensors, generate an eddy current in pulses

ii) Capacitive Proximity Sensors

- Detects changes in the capacitance blw the sensing object and sensor
- Capacitance varies on size of the two plates

iii) Magnetic Proximity Sensors

Reed end of the switch is operated by a mag
Read on, sensor or

App : i) Parking sensors
ii) Roller coastery
iii) Inductive sensor
iv) Mobile devices
v) Anti - aircraft warfare

- **IR Sensors**

Emits light in order to sense objects

Two types :-

Active : These sensor both emit and detect IR radiatⁿ
Two parts : LED & Receiver
When obj comes close, it detect and reflects

Passive : Two pyroelectric strips
An IR filter (blocks other wavelm)
A fresnel lens (collects light frm dift angle)

Apps : i) Proximity sensor used in smartphones
ii) Item Counter : cut the rad, item detected, count↑
iii) Burlgor alarm : transmitter & receiver cut
iv) Gas analyzer : detects gas density

• Pressure Sensor

- A transducer, senses pressur & convert it into elec signals
- Work on the principle of piezoelec effct, measured by strain gauge
- Converts force, pressure, compression into change in elec R

Working: i) Strain gauges are elec conductors tightly
ii) Attached to a film in a zigzag manner
iii) When film pulled off, conductor stretch & elungate
iv) Th change in shape causes R to chang

Types :-

i) Absolute pressure sensor :-
- Measures pressure related to perfect vaccum
- Used in industrial packaging & monitoring vaccum pumps

ii) Gauge Pressure Sensor :-
- Pressure relative to atmospheric pressure
- used in gauge pr. measurmnt

iii) Vaccum pressure sensor :-
- measures absolute pr. rel. to vac

iv) Differential Pressure Sensor :-
- Measure diff blw two pressures
- used to measure pressure drop across oil filters

v) Sealed Pressure Sensor :-
- Measures pressure rel. to some fixed pressure

App: i) Automated blg app
pressure sensors play majr role
ii) Adding pressure sensor to every consumer devic
iii) Industries

- **Biosensors**

- Consists of a sensor system & a transducer

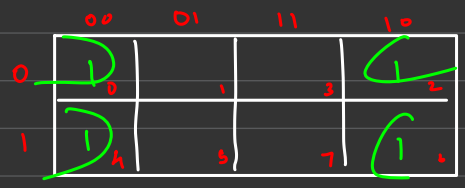
Construction: i) Three parts : sensor, transducer, associated es
ii) Responsive biological part & detector part
iii) finally a amplifier

Working: i) detects a position baseline signal, obtained from a related transducer

Features: two main comps: ampli & Trans
Bio comp identifies & communicate thru the analyte

Types: Electrochem Biosensr, Voltametric, Optical, Thermal, etc

Apps: i) detect analyte
ii) Screening sickness
iii) Drug improvemnt
iv) Veterniary apps.



$\bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C}$