$$\phi = 90^\circ - \theta$$

$$h = R\cos\phi$$

for a CW RADAR h can be determined.

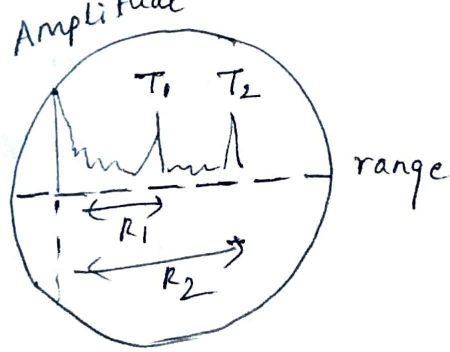
$$\Delta R \rightarrow \text{error} = \frac{c}{8 f_d}$$ $\boxed{\text{as } f_d \uparrow \ \Delta R \downarrow}$

error in slant Range can be minimized by adjusting the fd.

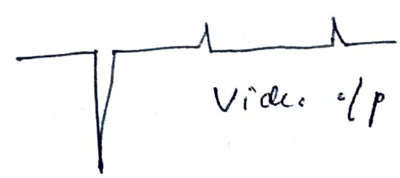
* Moving Target Integrator RADARS:-

They use A.Scope or PPI displays or the CRT displays.

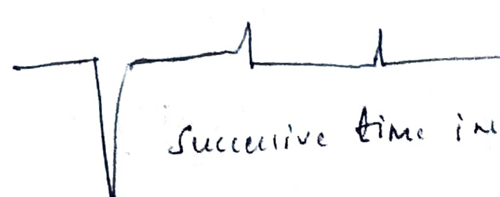
Whenever you consider A. Scope display



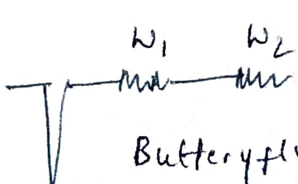
We consider the o/p for successive time instants



Video o/p at $t = t_1$



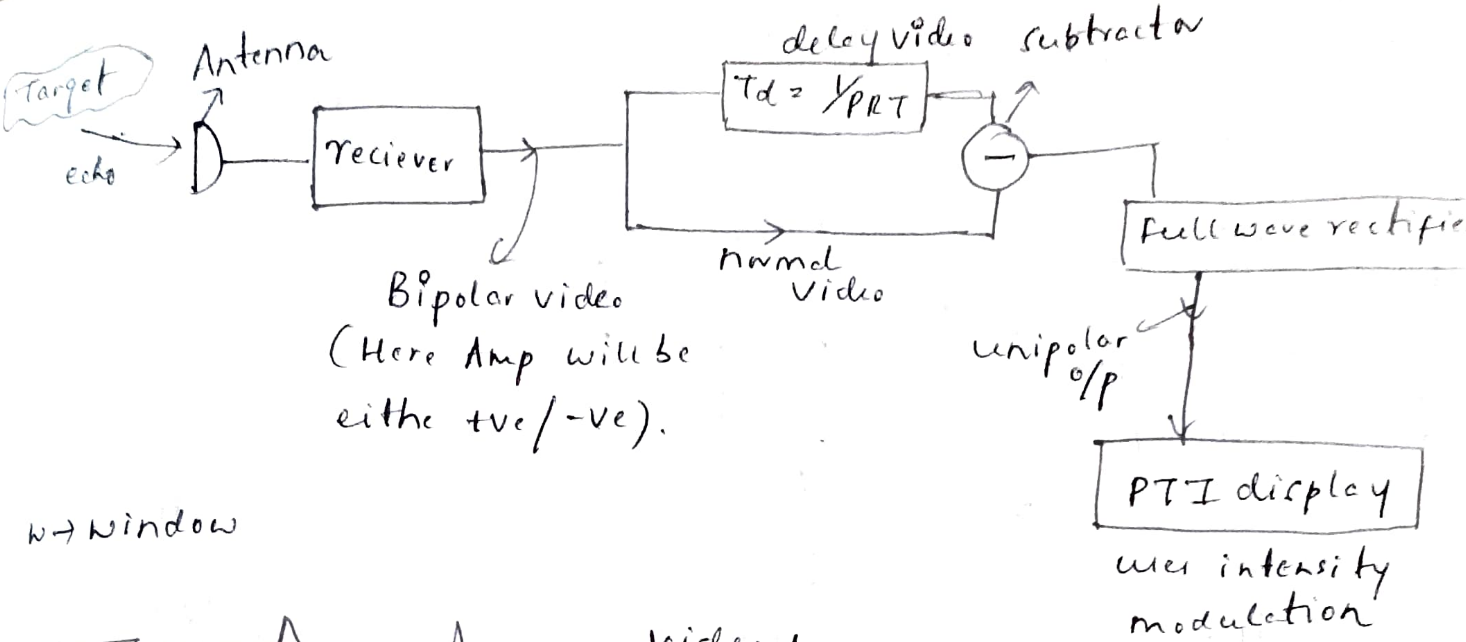
Successive time instant t_2



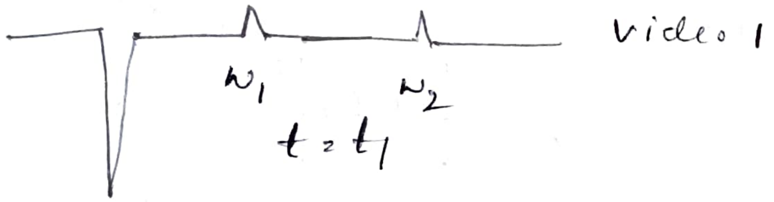
Butterfly patterns

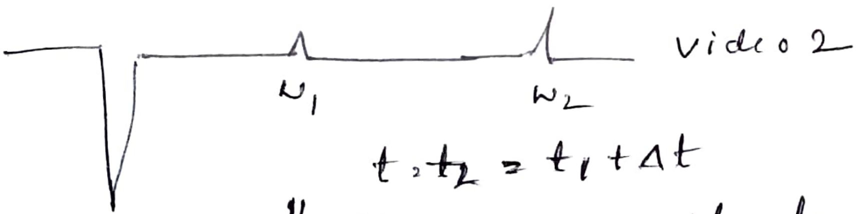
↓ indicate moving targets

Basic principle of MIT system



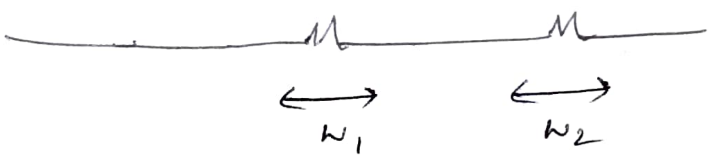
w → window





$t = t_2 = t_1 + \Delta t$

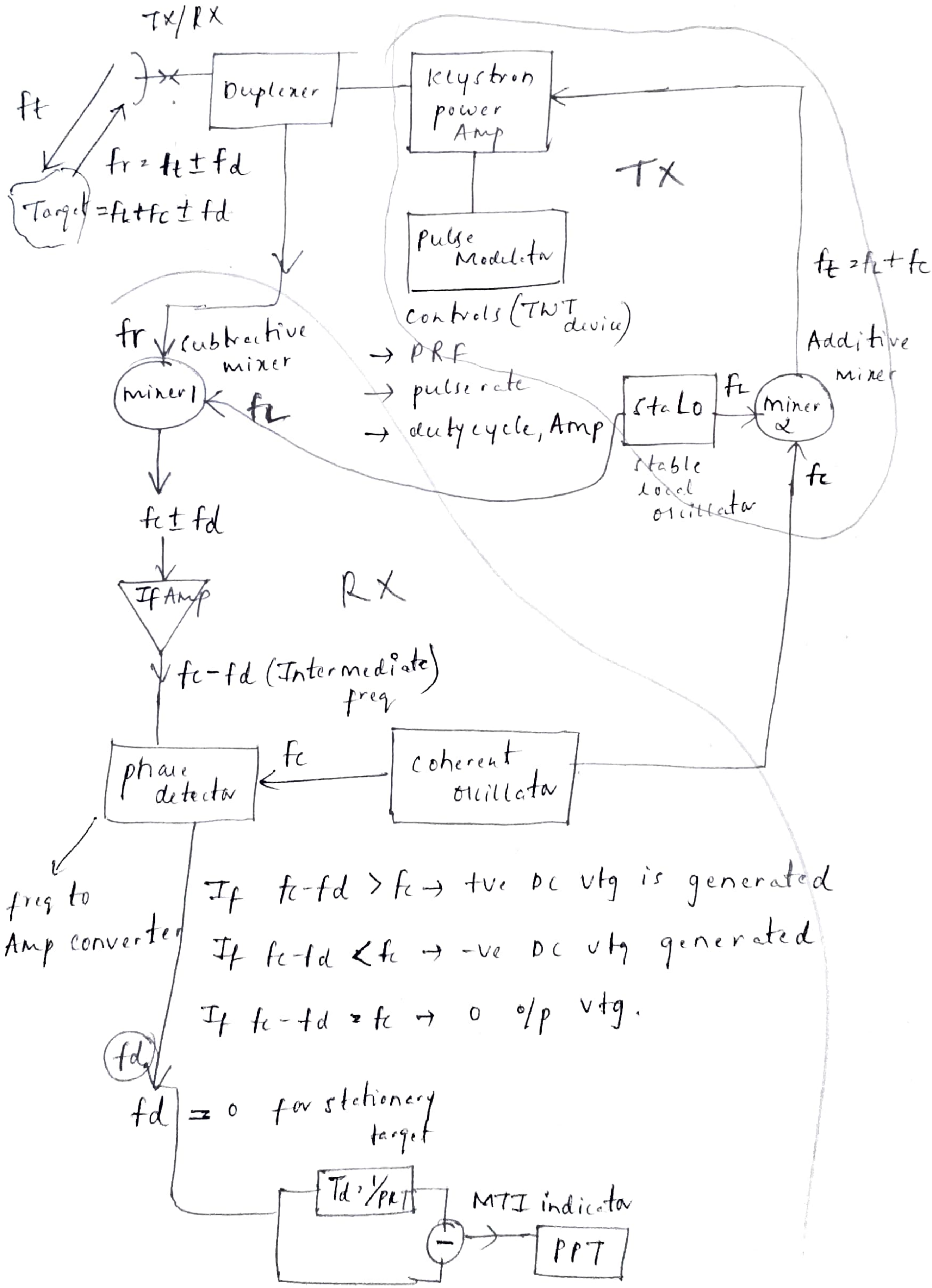
⇓ through a subtractor.



cancellation of permenant echos must be possible, then only you can view your moving target perfectly.

Power Amplifier (listen to the lecture)

Power Amplifier type MIT radar :-



If $f_c - f_d > f_c$ → +ve DC vtg is generated

If $f_c - f_d < f_c$ → −ve DC vtg generated

If $f_c - f_d = f_c$ → 0 o/p vtg.

Mathematical equations

$\rightarrow$ $V_t = A_1 \sin 2\pi f_t t$

$A_1 \rightarrow$ Amp txn by the Antenna

$\rightarrow$ $V_{echo} = A_2 \sin\left[2\pi f_t t \pm f_d t - \frac{4\pi f_t R_0}{c}\right]$

$R_0 \rightarrow$ Range of the target

$c \rightarrow 3\times10^8$ m/sec

$\rightarrow$ the difference signal from mixer 1:- In MTI RADAR

$$V_{diff} = A_3 \sin\left(2\pi f_d t - \frac{4\pi f_t R_0}{c}\right)$$

suppose $f_d = 0$ (stationary targets)

Now A_3 will vary b/w +ve & -ve value.

And, V_{diff} doesnot vary with respect to time

suppos moving target, $f_d \neq 0$, Then V_{diff} will depend on the time. Target can be detected on the screen.

* We encounter Blind speed in MTI system:-

If in MTI reciever, the phase diff b/w two successive pulses ~~frequency~~ is 2π radians. This means, no phase change. Hence, the system will assume that it is an echo from stationary target, & so it blindly cancels that ~~region~~ echo signals.

This result in loss of info.

$$V_{bn} = \frac{(PRF)\, n\lambda}{2}$$

PRF $\rightarrow$ pulse repetition freq

$n \rightarrow$ order of Blind speed

(fn of λ of txn).

Remedy to overcome :-

(1) operate at longer wavelength / low frequency then V_B will be very large, it can be compared with practical velocity values.

(2) Constantly change λ such that we can avoid echo cancellation.

(3) operate with higher PRF.

* characterstics :-

→ It can be used with pulse RADAR / Cont RADAR

→ low Range ambiguity. $\approx \frac{c}{PRF}$

→ If we can determine f_d, then we can determine the radial velocity.

→ correct determination of Moving targets is possibly, by eleminating echos of permenant targets.

→ Ground is eleminated. Background noise is eleminated.

* Applications :-

→ Air traffic controle - Both landing & takeoff

→ Ground base RADARS – in police RADARS
(monitoring traffic) (speed limit).

→ Monitoring of ships (light house).

→ used in free space for satellite tracking

→ Missile Guidance

→ oil & Natural Gas Commission support

→ Mobile Applications (GPS

→ Sea Mapping. & flood Mapping

→ Tsunami & Earthquake monitoring.

→ Military Application in monitoring enemy targets.
↳ Satellite locations

*

* Scanning Principles:-

→ rotating the antenna in regular pattern which generates a radiation pattern which the system will be able to detect presence or absence of target.

→ Radiation pattern generated is used to detect the targets.

Requirements for selecting the Antenna

→ Antenna must be compactable.
(moving, shorter & enumerable.)

→ Antenna must withstand wind loading

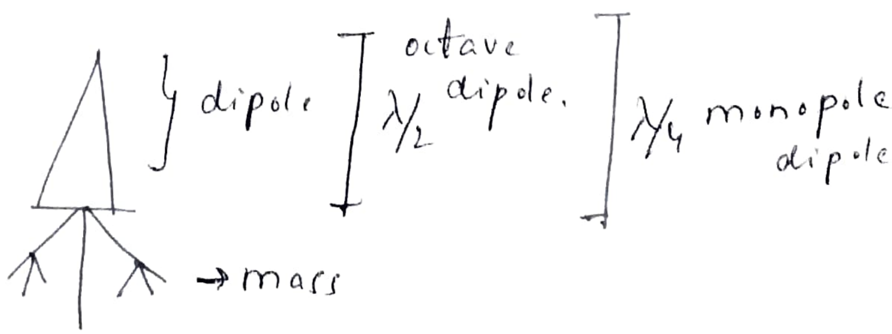
→ We must use smaller smaller driver motors.

→ Antenna must be easily tilted, rotated, moved.

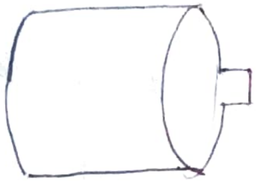
→ No losses in the Antenna.

* Types of Antenna used:-

→ Dipole Antenna



→ conventional dish.



(for this topic refer to sir's notes)

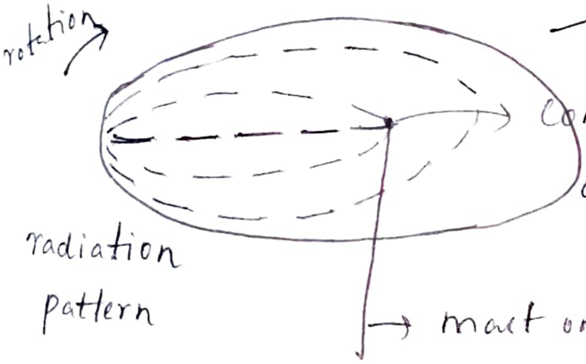
→ paraboloid cylinder antenna

→ pill box Antenna

* Types of scanning:-

(1) Horizontal scanning:-

correction in diagram refer sir notes

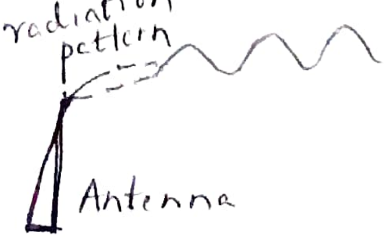


Consider the antenna as a point source

→ mast on which Antenna is located

When we rotate the antenna horizontally, it would trace out a circle as shown.
This will be used in plane to plane communication and even ship-to-ship comm, terrestrial comm.

(2). Noding scan:-



It moves such a way that it produces sinusoidal radiation pattern.

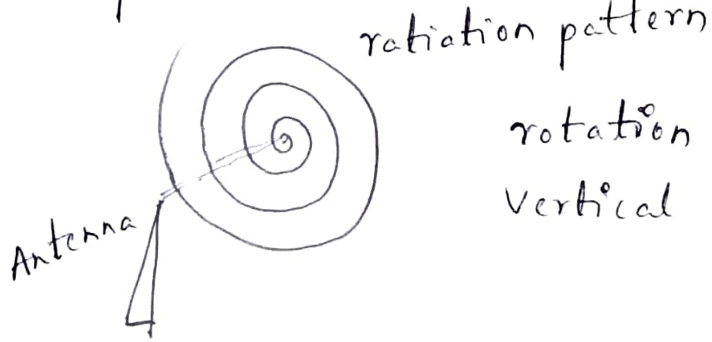
→ Also called vertical scanning

→ Used in tracking of heavenly bodies, stars, commets etc.

→ Used in Air navigation :- When plane moves from one location to other. There is always a link with the plane to check its status Movement of plane is monitored at every instant.

(3). Spiral Scanning :-

Tip of the antenna is rotated in clockwise/ Anticlockwise direction so as to trace out a spiral path



rotation occurs in the Vertical plane.

→ Military & defence applications in missile guidance & launching

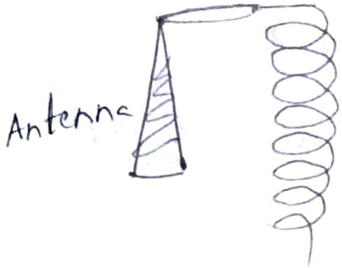
→ finding aircrafts

→ commanding targets.

(4). Helical Scanning :-

The antenna is rotated both horizontally & vertically so as to trace out Helix.

→ Used in Satellite communication

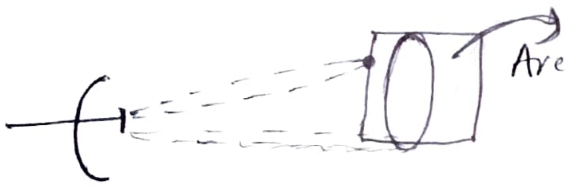


→ ILS (Instrument landing system).

→ mostly used in Search Radars (All Antennas considered upto now, Horizontal, Noding, Spiral).

(5). Conical Scanning :-

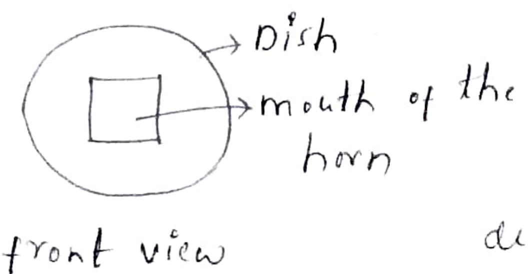
Generally used in Tracking RADARS.



Antenna must make contact with the target and establish a link. For this antenna must be rotated in such a way that it produces an elipptical of clockwise / anticlockwise

→ Generally used for setting the microwave link with the systems.

Consider a dish Antenna

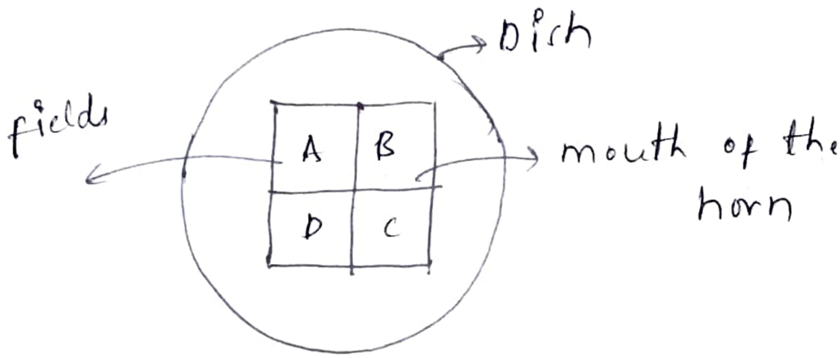


for short distance comm.

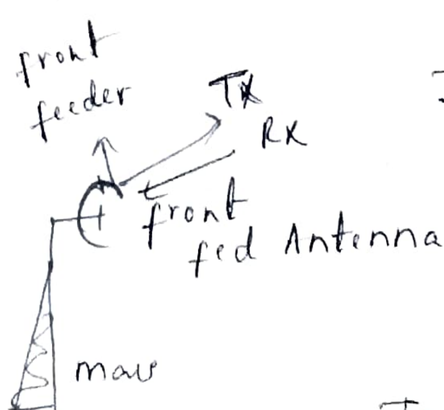
→ This is used for both Tx & Rx purpose.

→ The recieved echo is detected by the horn and then moves to the reciever.

for long distance comm, we will face the problem of maximum Anamaloys (mean's the reciever must need sufficient amount of time to detect the echo). Hence we need to use a multi field Antenna.

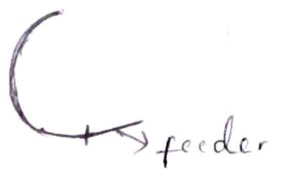


We will have a decision making ckt, which connects a particular field (A/B/C/D) to the reciever. The strongest echo recieved by the four fields (A B C D) will be processed. This is for better detection. This is also called the Maximum signal coupling.



It is a parabolic dish. The mouth of the dish contains redirect elements in the front side, so as to Tx & Rx echo.

If the target is located very close, then you get an echo very soon. In case of multiple ~~aden~~ targets monitoring there will be confusion. Hence, we mount a recieving antenna at the backside.



Suppose, the recieving echo comes along the axis of the antenna, the the feeder is placed in such manner as shown.

This only the Rx antenna.

for Tx we will have to use a diff antenna.

Whenever you want to Rx a best signal, then you need to go for multiple Antenna, multiple imaging wrt the rx system. This is called the diversity reception method

* Diversity Reception method :-

(1) Space diversity :- Use multiple Antenna arranged in a regular pattern. Suppose it is dopler radar, for inline reception we recieve no dopler frequency, so we have to

switch on the antenna which has orthogonal reception, so that the signal will be having maximum doppler shift.

(2). frequency diversity:- change the frequencies regularly wrt tx and Rx

(3). polarisation Diversity :-

Three forms of polarisation

↳ linear

↳ Circular

↳ elliptical

Using different polarisation to different targets.

with the help of diversity of reception methods correct detection of targets is possible which in turn helps in detecting correct range, presence or absence of target, direction of motion, elevation