

# Unit → 5

## 1) Special purpose Radars...

### # Doppler RADAR...

A specialized radar system that utilizes the doppler effect to determine the velocity of objects in relation to the radar.

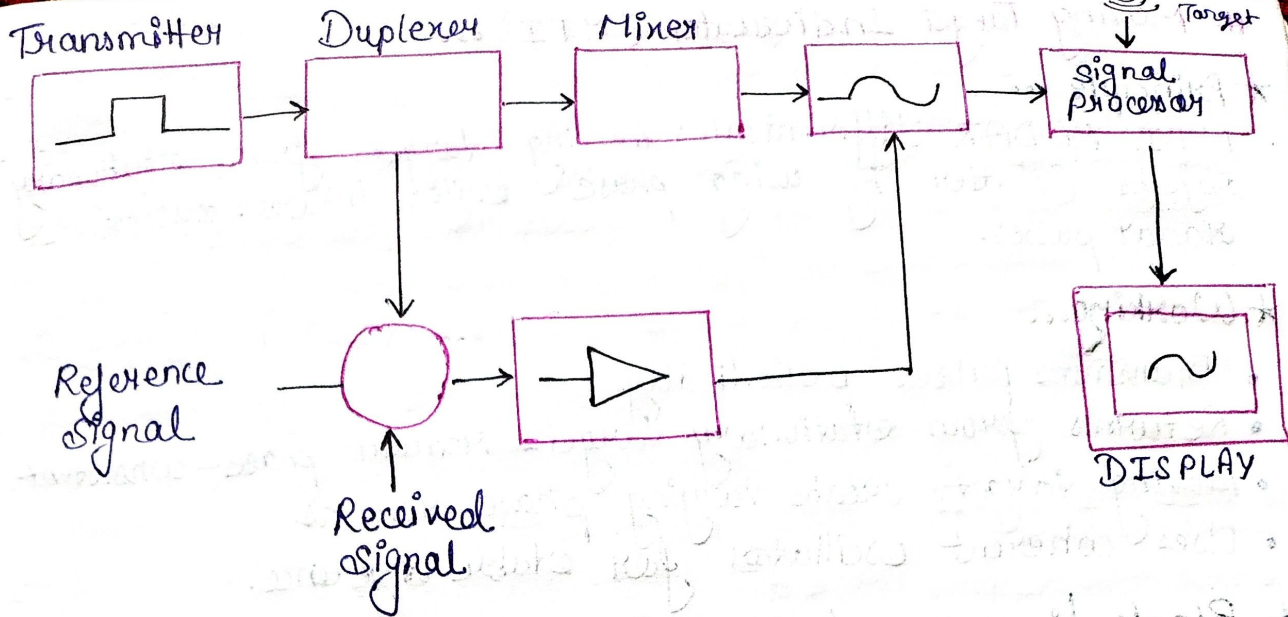
#### \* Working ...

- Transmits continuous wave or pulsed signal towards a moving object.
- Reflected signal has a frequency shift proportional to the object's speed.
- The difference between transmitted and received frequency (doppler shift) provides velocity information.
- It works by sending out radio waves and analyzing how the frequency of the returning waves changes when reflected off a moving target.
- This frequency shift, known as the doppler shift, provides a direct measurement of the target's radial velocity (movement towards or away from the radar).

#### \* Principle ...

Doppler radar is based on the doppler effect, which describes the changes in frequency of a wave in relation to an observer moving relative to the wave source. In radar, it measures the velocity of an object by detecting changes in the frequency of the returned signal.

#### \* Block diagram of doppler radar ...



### ➤ Transmitter

Generates high frequency microwave signals.

- Antenna  
Radiates signal towards the target and collects echoes.
- Duplexer  
Switches between transmission and reception.
- Receiver  
Amplifies and processes the return signal.
- Mixer  
Combines received signal with a reference to extract frequency shift.
- Signal Processor  
Calculates speed using doppler shift.
- Display  
Shows target speed.

### \* Applications...

- Weather monitoring (storm tracking, rainfall measurement).
- Police speed detection.
- Aviation (velocity measurement of aircraft).
- Military (target tracking).

## # Moving Target Indicator (MTI) ...

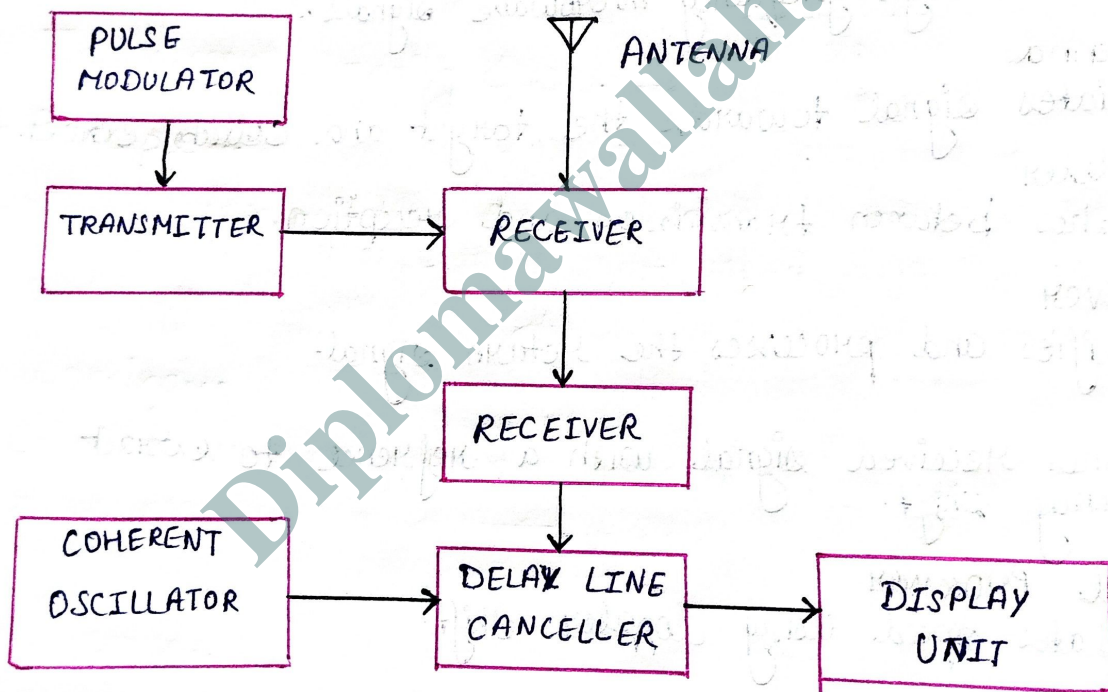
### ★ Principle ...

MTI RADAR differentiates moving targets from stationary objects (clutter) by using phase shifts between successive radar pulses.

### ★ Working...

- Transmits pulses periodically.
- Returns from stationary targets remain phase-consistent.
- Moving targets create varying phase returns.
- Uses coherent oscillator for stable reference.

### ★ Block diagram of MTI Radar...



- Pulse modulator: Create radar pulses.
- Transmitter: Amplifies and sends pulses.
- Antenna: Transmits and receives signals.
- Receiver: Detects and amplifies return signals.
- Coherent Oscillator: - Provides stable reference phase
- Delay line canceller: Compares successive echoes to identify movement.
- Display Unit: Highlights moving targets.

### \* Applications...

- Air traffic control.
- Military surveillance.
- Weather radar.
- Maritime navigation.

## 2.) Secondary Surveillance Radar (SSR)...

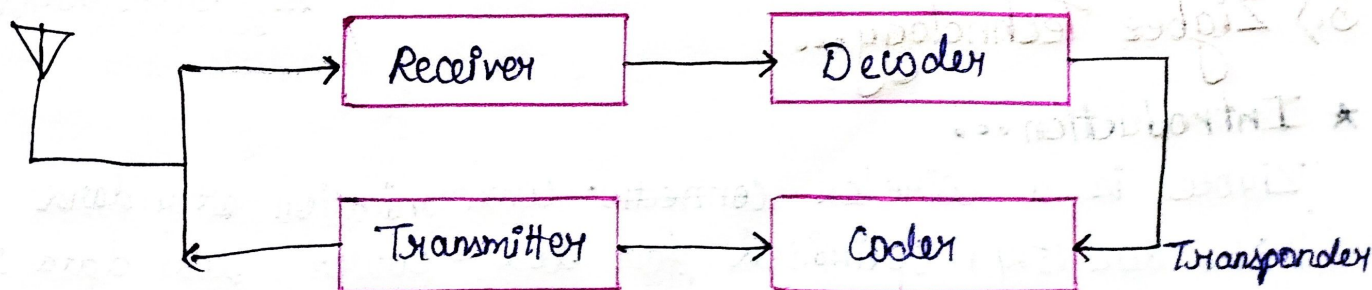
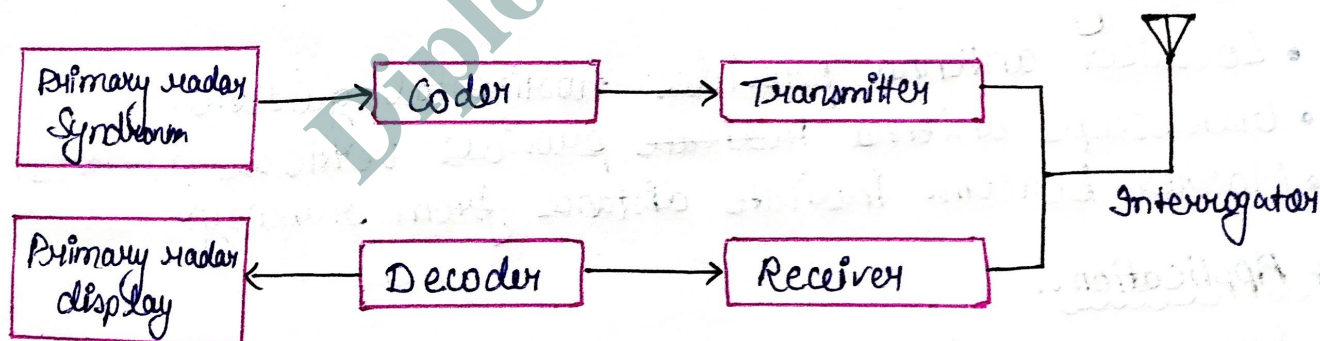
### \* Principle...

Unlike primary radar that detects reflected signals, SSR uses transponders on aircraft to receive an interrogation signal and send back a coded response, giving precise identification and altitude.

### \* Working...

- Ground station transmits interrogation pulses (Mode A, C or S).
- Aircraft transponder replies with identification code and altitude.
- SSR processes and displays this information.

### \* Block diagram of SSR...



Secondary surveillance radar is a system used in ATC (Air traffic control), that unlike primary radar system that measure the bearing and distance of targets using the detected reflections of radio signals, relies on targets equipped with a radar transponder encoded data such as identity code, the aircraft is altitude and further information depending on its chosen mode. SSR is based on the military identification friend and foe (IFF) technology originally developed during World War II.

### \* Application ...

- Air traffic management.
- Collision avoidance.
- Enhanced identification of aircraft.

### # Instrument Landing System...

#### \* Principle ...

It provides precise lateral (localize) and vertical (glideslope) guidance to aircraft approaching a runway, especially in poor visibility.

#### \* Working...

- Localizer antenna provides horizontal guidance.
- Glideslope antenna indicate provides vertical guidance.
- Marker beacons indicate distance from runway.

#### \* Application..

- Ensure safe aircraft landings in low visibility.
- Standard in commercial aviation.

### 3.) Zigbee Technology...

#### \* Introduction...

Zigbee is a wireless communication standard (IEEE 802.15.4) optimised for low-power, low data rate short-range communication, primarily used in IOT (Internet of Things) applications.

## # Zigbee Architecture Layers...

- 1.) Physical Layer (PHY)
  - Handles modulation/demodulation, transmission/reception.
  - Frequency 2.4 GHz globally.
- 2.) Medium Access Control (MAC) layer:
  - Manage channel access, data transmission, frame validation.
- 3.) Network (NWK) layer:
  - Responsible for routing, addressing, joining/leaving networks.
- 4.) Application Support (APS) layer:
  - Interfaces between application object and network layer.
- 5.) Application layers:
  - Contains user applications (smart devices, sensors).

## Zigbee devices...

- Coordinator: Forms the network, managing communications.
- Router: Extends coverage by forwarding data.
- End Devices: Low-power device that sends/receives data but does not route.

## # Network topologies...

- 1.) Star topology:
  - One central coordinator.
  - End devices communicate directly with the coordinator.
- 2.) Tree topology:
  - Hierarchical with parent-child relationships.
  - Supports scalability.
- 3.) Mesh topology:
  - Devices interconnect dynamically.
  - Robust and self-healing network.

## ★ Applications of Zigbee ...

- Home automation

Smart lighting, thermostats, security systems

- Industrial automation

Sensor networks, energy management.

- Healthcare

Patient monitoring, medical device control.

- Agriculture

Smart irrigation, environmental monitoring.

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