

RS QUIZ-4 [THEORY]

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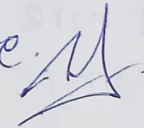
① Radar Parameters:-

- PRI = $6\mu s$
- PRF = $\frac{1}{6\mu s} = 166.67 \text{ kHz}$
- Pulse Width (τ) = $(0.10) 6\mu s = 0.6\mu s$
- Code Length = 16 bits (N-Code)
- Bit Duration (T_{bit}) = $\frac{0.6\mu s}{16} = 37.5 \text{ ns}$
- Bandwidth (BW) $\approx \frac{1}{T_{\text{bit}}} = 26.67 \text{ MHz}$
- Carrier freq: $f_c = 77 \text{ GHz}$
- $\lambda = \frac{c}{f_c} = 3.90 \text{ mm}$

① Range resolution Analysis:-

$$\Delta R = \frac{c}{2 \cdot \text{BW}} = \frac{c \cdot T_{\text{bit}}}{2} = \frac{(3 \times 10^8) (37.5 \times 10^{-9})}{2} = \underline{\underline{5.625 \text{ m}}}$$

Two targets are at 100m and 50m, so their range separation is 50m, which is significantly larger than range resolution of 5.625m.

∴ The targets are clearly resolved in range. 

② Doppler Resolution Analysis:-

$$\text{Doppler Res: } \Delta V = \frac{\lambda}{2 \times \text{CPI}} ; \quad \lambda = \frac{c}{f} = 3.9 \text{ mm (calculated above)}$$

$$\text{CPI} = 128 \text{ pulses} \times 6\mu s = \underline{\underline{768 \mu s}}$$

$$\therefore \Delta V = \frac{3.9 \times 10^{-3}}{2 \times 768 \times 10^{-6}} = \underline{\underline{2.539 \text{ m/s}}}$$

The two targets have velocities -5 m/s and 2.5 m/s giving a velocity difference of 7.5 m/s , which is larger than the Doppler resolution of 2.539 m/s .
 \Rightarrow Targets resolved in Doppler velocity.

③ Joint Doppler-Range Resolution:-

Since the targets are resolved both in range (separated by 50 m with a resolution of 5.625 m) and in Doppler (separated by 7.5 m/s with a resolution of 2.539 m/s); hence, they appear as distinct peaks in range-Doppler map.

\Rightarrow Targets are resolved in both range & doppler velocity.

④ Unambiguous Range and Velocity Analysis:-

$$\bullet R_{\text{max}} |_{\text{unamb.}} = \frac{C \cdot \text{PRI}}{2} = \frac{3 \times 10^8 \times 6 \times 10^{-6}}{2} = 900 \text{ m}$$

$$\bullet V_{\text{max}} |_{\text{unamb.}} = \frac{\lambda}{4 \cdot \text{PRI}} = \frac{3 \cdot 9 \times 10^{-3}}{4 \times 6 \times 10^{-6}} = 162.5 \text{ m/s}$$

Target 1: Range = 100 m ; |Velocity| = 5 m/s

Target 2: Range = 50 m ; |Velocity| = 2.5 m/s

Both targets have ranges (100 m and 50 m) well within the max. unambig. range of 900 m .

Similarly; both targets have velocities well within the max. unambig. velocity of 162.5 m/s .

∴ Both targets are within the unambiguous limits for both range and doppler velocity.