Radar

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Notation

- F Receiver noise factor
- G_r Receiver gain
- G_t Transmitter gain
- L General loss factor
- P_r Received power (Watts)
- P_t Transmit power (Watts)
- R_r Range from receiver to target (m)
- R_t Range from transmitter to target (m)
- T effective noise temperature (°K)
- k_B Boltzmann's constant $\approx 1.38 \times 10^{-23} \frac{\text{J}}{\text{K}}$
- λ Radar operating frequency wavelength (m)
- σ Target radar cross section (m^2)
- τ pulse duration (s)

If the radar is monostatic then $G_r = G_t$ and $R_r = R_t$.

1. **Radar equation**

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R_t^2 R_r^2 L}$$

2. **Noise** (assuming the white noise power spectral density (PSD) is kT)

$$N = \frac{kTF}{\tau}$$

3. **Signal to Noise ratio** (SNR) usually expressed in dB

$$\text{SNR} = \frac{P_r}{N} \qquad \text{SNR in dB} = 10 \log_{10} \left(\frac{P_r}{N} \right)$$

4. *Maximal* radar cross section (a is a characteristic length)
   (a) corner reflectors (a is a characteristic length)
      i. dihedral: $\sigma = \dfrac{8\pi a^4}{\lambda^2}$
      ii. trihedral: $\sigma = \dfrac{12\pi a^4}{\lambda^2}$
   (b) planar surface of area A: $\sigma = \dfrac{4\pi A^2}{\lambda^2}$
   (c) right circular cylinder (radius a, height b): $\sigma = \dfrac{2\pi a b^2}{\lambda}$
   (d) sphere of radius a: $\sigma = \pi a^2$

Standard Radar Frequency Letter-Band Nomenclature(IEEE Standard 521-1984)

Band	Frequency	Wavelength
L band	1–2 GHz	30.0–15.0 cm
S band	2–4 GHz	15–7.5 cm
C band	4–8 GHz	7.5–3.8 cm
X band	8–12 GHz	3.8–2.5 cm
Ku band	12–18 GHz	2.5–1.7 cm
K band	18–27 GHz	1.7–1.1 cm
Ka band	27–40 GHz	1.1–0.75 cm
V band	40–75 GHz	0.75–0.40 cm
W band	75–110 GHz	0.40–0.27 cm