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Radar & Antenna Specifications Formulas

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List of 24 Radar & Antenna Specifications Formulas

Radar & Antenna Specifications

1) Antenna Aperture Efficiency

Open Calculator

fx $$\eta_a = \frac{A_{eff}}{A_a}$$

ex $$0.7 = \frac{17.5875\text{m}^2}{25.125\text{m}^2}$$

2) Antenna Area

Open Calculator

fx $$A_a = \frac{A_{eff}}{\eta_a}$$

ex $$25.125\text{m}^2 = \frac{17.5875\text{m}^2}{0.7}$$

3) Cumulative Probability of Detection

Open Calculator

fx $$p_c = 1 - (1 - p_{detect})^n$$

ex $$0.4375 = 1 - (1 - 0.25)^2$$

4) Doppler Angular Frequency

Open Calculator

fx $\omega_d = 2 \cdot \pi \cdot f_d$

ex $64.71681\text{rad/s} = 2 \cdot \pi \cdot 10.3\text{Hz}$

5) Doppler Frequency

Open Calculator

fx $f_d = \frac{\omega_d}{2 \cdot \pi}$

ex $10.30003\text{Hz} = \frac{64.717\text{rad/s}}{2 \cdot \pi}$

6) Effective Area of Receiving Antenna

Open Calculator

fx $A_{eff} = A_a \cdot \eta_a$

ex $17.5875\text{m}^2 = 25.125\text{m}^2 \cdot 0.7$

7) Maximum Gain of Antenna

Open Calculator

fx $G_{max} = \frac{\rho_{max}}{\rho}$

ex $1.5\text{dB} = \frac{15\text{kW/m}^3}{10\text{kW/m}^3}$

8) Maximum Power Density Radiated by Antenna

Open Calculator

fx $\rho_{max} = \rho \cdot G_{max}$

ex $15\text{kW/m}^3 = 10\text{kW/m}^3 \cdot 1.5\text{dB}$

9) Maximum Range of Radar

Open Calculator

fx $R_t = \left(\frac{P_{trns} \cdot G_{trns} \cdot \sigma \cdot A_{eff}}{16 \cdot \pi^2 \cdot S_{min}} \right)^{0.25}$

ex $289.6204\text{m} = \left(\frac{100\text{kW} \cdot 657 \cdot 25\text{m}^2 \cdot 17.5875\text{m}^2}{16 \cdot \pi^2 \cdot 0.026\text{W}} \right)^{0.25}$

10) Maximum Unambiguous Range

Open Calculator

fx $R_{un} = \frac{[c] \cdot T_{pulse}}{2}$

ex $8.789915\text{km} = \frac{[c] \cdot 58.64\mu\text{s}}{2}$

11) Measured Runtime

Open Calculator

fx $T_{run} = 2 \cdot \frac{R_t}{[c]}$

ex $1.932137\mu\text{s} = 2 \cdot \frac{289.62\text{m}}{[c]}$

12) Minimum Detectable Signal

Open Calculator

fx $$S_{min} = \frac{P_{trns} \cdot G_{trns} \cdot \sigma \cdot A_{eff}}{16 \cdot \pi^2 \cdot R_t^4}$$

ex $$0.026\text{W} = \frac{100\text{kW} \cdot 657 \cdot 25\text{m}^2 \cdot 17.5875\text{m}^2}{16 \cdot \pi^2 \cdot (289.62\text{m})^4}$$

13) N Scans

Open Calculator

fx $$n = \frac{\log 10(1 - p_c)}{\log 10(1 - p_{detect})}$$

ex $$2 = \frac{\log 10(1 - 0.4375)}{\log 10(1 - 0.25)}$$

14) Power Density Radiated by Lossless Antenna

Open Calculator

fx $$\rho = \frac{\rho_{max}}{G_{max}}$$

ex $$10\text{kW/m}^3 = \frac{15\text{kW/m}^3}{1.5\text{dB}}$$

15) Probability of Detection

Open Calculator

fx $$p_{detect} = 1 - (1 - p_c)^{\frac{1}{n}}$$

ex $$0.25 = 1 - (1 - 0.4375)^{\frac{1}{2}}$$

16) Pulse Repetition Frequency

Open Calculator

$$f_{rep} = \frac{[c]}{2 \cdot R_{un}}$$

$$17053.04\text{Hz} = \frac{[c]}{2 \cdot 8.79\text{km}}$$

17) Pulse Repetition Time

Open Calculator

$$T_{pulse} = \frac{2 \cdot R_{un}}{[c]}$$

$$58.64057\mu\text{s} = \frac{2 \cdot 8.79\text{km}}{[c]}$$

18) Radar Antenna Height

Open Calculator

$$H_a = \frac{\Delta R \cdot R_o}{2 \cdot H_t}$$

$$450\text{m} = \frac{9\text{m} \cdot 40000\text{m}}{2 \cdot 400\text{m}}$$

19) Radial Velocity

Open Calculator

$$v_r = \frac{f_d \cdot \lambda}{2}$$

$$2.987\text{m/s} = \frac{10.3\text{Hz} \cdot 0.58\text{m}}{2}$$

20) Range of Target

Open Calculator

$$R_t = \frac{[c] \cdot T_{run}}{2}$$

$$289.5995\text{m} = \frac{[c] \cdot 1.932\mu\text{s}}{2}$$

21) Target Height

Open Calculator

$$H_t = \frac{\Delta R \cdot R_o}{2 \cdot H_a}$$

$$400\text{m} = \frac{9\text{m} \cdot 40000\text{m}}{2 \cdot 450\text{m}}$$

22) Target Velocity

Open Calculator

$$v_t = \frac{\Delta f_d \cdot \lambda}{2}$$

$$5.8\text{m/s} = \frac{20\text{Hz} \cdot 0.58\text{m}}{2}$$

23) Transmitted Frequency

Open Calculator

$$f_{trns} = f_d \cdot \frac{[c]}{2 \cdot v_r}$$

$$5.2\text{E}\hat{}8\text{Hz} = 10.3\text{Hz} \cdot \frac{[c]}{2 \cdot 2.987\text{m/s}}$$

24) Transmitted Gain

Open Calculator

fx $$G_{trns} = \frac{4 \cdot \pi \cdot A_{eff}}{\lambda^2}$$

ex $$656.9888 = \frac{4 \cdot \pi \cdot 17.5875\text{m}^2}{(0.58\text{m})^2}$$

Variables Used

- A_a Antenna Area *(Square Meter)*
- A_{eff} Effective Area of Receiving Antenna *(Square Meter)*
- f_d Doppler Frequency *(Hertz)*
- f_{rep} Pulse Repetition Frequency *(Hertz)*
- f_{trns} Transmitted Frequency *(Hertz)*
- G_{max} Maximum Gain of Antenna *(Decibel)*
- G_{trns} Transmitted Gain
- H_a Antenna Height *(Meter)*
- H_t Target Height *(Meter)*
- n N Scans
- p_c Cumulative Probability of Detection
- p_{detect} Detection Probability of Radar
- P_{trns} Transmitted Power *(Kilowatt)*
- R_o Range *(Meter)*
- R_t Target Range *(Meter)*
- R_{un} Maximum Unambiguous Range *(Kilometer)*
- S_{min} Minimum Detectable Signal *(Watt)*
- T_{pulse} Pulse Repetition Time *(Microsecond)*
- T_{run} Measured Runtime *(Microsecond)*
- v_r Radial Velocity *(Meter per Second)*

- v_t Target Velocity *(Meter per Second)*
- Δf_d Doppler Frequency Shift *(Hertz)*
- ΔR Range Resolution *(Meter)*
- η_a Antenna Aperture Efficiency
- λ Wavelength *(Meter)*
- ρ Lossless Isotropic Power Density *(Kilowatt Per Cubic Meter)*
- ρ_{max} Maximum Radiated Power Density *(Kilowatt Per Cubic Meter)*
- σ Cross Section Area of Radar *(Square Meter)*
- ω_d Doppler Angular Frequency *(Radian per Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[c]**, 299792458.0 Meter/Second
  Light speed in vacuum
- Function: **log10**, log10(Number)
  Common logarithm function (base 10)
- Measurement: **Length** in Meter (m), Kilometer (km)
  Length Unit Conversion
- Measurement: **Time** in Microsecond (µs)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Kilowatt (kW), Watt (W)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Sound** in Decibel (dB)
  Sound Unit Conversion
- Measurement: **Power Density** in Kilowatt Per Cubic Meter (kW/m³)
  Power Density Unit Conversion
- Measurement: **Angular Frequency** in Radian per Second (rad/s)
  Angular Frequency Unit Conversion

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- **Radar & Antenna Specifications Formulas**
- **Radar Antennas Reception Formulas**
- **Special Purpose Radars Formulas**

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