Important Radar & Antenna Specifications Formulas PDF

Formulas
Examples
with Units

List of 24
Important Radar & Antenna Specifications Formulas

1) Antenna Aperture Efficiency Formula

Evaluate Formula

Formula

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

Example with Units

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

2) Antenna Area Formula

Evaluate Formula

Formula

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

Example with Units

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

3) Cumulative Probability of Detection Formula

Evaluate Formula

Formula

$$p_c = 1 - \left(1 - p_{detect}\right)^n$$

Example

$$0.4375 = 1 - \left(1 - 0.25\right)^2$$

4) Doppler Angular Frequency Formula

Evaluate Formula

Formula

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

Example with Units

$$64.7168\,\text{rad/s} = 2 \cdot 3.1416 \cdot 10.3\,\text{Hz}$$

5) Doppler Frequency Formula

Evaluate Formula

Formula

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

Example with Units

$$10.3\,\text{Hz} = \frac{64.717\,\text{rad/s}}{2 \cdot 3.1416}$$

6) Effective Area of Receiving Antenna Formula

Evaluate Formula

Formula

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

Example with Units

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

7) Maximum Gain of Antenna Formula

Evaluate Formula

Formula

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

Example with Units

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

8) Maximum Power Density Radiated by Antenna Formula

Evaluate Formula

Formula

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

Example with Units

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

9) Maximum Range of Radar Formula

Evaluate Formula

Formula

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

Example with Units

$$289.6204\,\text{m} = \left(\frac{100\,\text{kW} \cdot 657 \cdot 25\,\text{m}^2 \cdot 17.5875\,\text{m}^2}{16 \cdot 3.1416^2 \cdot 0.026\,\text{W}} \right)^{0.25}$$

10) Maximum Unambiguous Range Formula

Evaluate Formula

Formula

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

Example with Units

$$8.7899\,\text{km} = \frac{3\text{E+8}\,\text{m/s} \cdot 58.64\,\mu\text{s}}{2}$$

11) Measured Runtime Formula

Evaluate Formula

Formula

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

Example with Units

$$1.9321\,\mu\text{s} = 2 \cdot \frac{289.62\,\text{m}}{3\text{E+8}\,\text{m/s}}$$

12) Minimum Detectable Signal Formula

Evaluate Formula

Formula

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

Example with Units

$$0.026\,\text{W} = \frac{100\,\text{kW} \cdot 657 \cdot 25\,\text{m}^2 \cdot 17.5875\,\text{m}^2}{16 \cdot 3.1416^2 \cdot 289.62\,\text{m}^4}$$

13) N Scans Formula

Evaluate Formula

Formula

$$n = \frac{\log10\left(1 - p_c\right)}{\log10\left(1 - p_{detect}\right)}$$

Example

$$2 = \frac{\log10\left(1 - 0.4375\right)}{\log10\left(1 - 0.25\right)}$$

14) Power Density Radiated by Lossless Antenna Formula

Evaluate Formula

Formula

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

Example with Units

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

15) Probability of Detection Formula

Evaluate Formula

Formula

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

Example

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

16) Pulse Repetition Frequency Formula

Evaluate Formula

Formula

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

Example with Units

$$17053.0408\,\text{Hz} = \frac{3E{+}8\,\text{m/s}}{2 \cdot 8.79\,\text{km}}$$

17) Pulse Repetition Time Formula

Evaluate Formula

Formula

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

Example with Units

$$58.6406\,\mu\text{s} = \frac{2 \cdot 8.79\,\text{km}}{3E{+}8\,\text{m/s}}$$

18) Radar Antenna Height Formula

Evaluate Formula

Formula

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

Example with Units

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

19) Radial Velocity Formula

Evaluate Formula

Formula

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

Example with Units

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

20) Range of Target Formula

Evaluate Formula

Formula

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

Example with Units

$$289.5995\,\text{m} = \frac{3E{+}8\,\text{m/s} \cdot 1.932\,\mu\text{s}}{2}$$

21) Target Height Formula

Evaluate Formula

Formula

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

Example with Units

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

22) Target Velocity Formula

Evaluate Formula

Formula

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

Example with Units

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

23) Transmitted Frequency Formula

Evaluate Formula

Formula

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

Example with Units

$$5.2E{+}8\,\text{Hz} = 10.3\,\text{Hz} \cdot \frac{3E{+}8\,\text{m/s}}{2 \cdot 2.987\,\text{m/s}}$$

24) Transmitted Gain Formula

Evaluate Formula

Formula

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

Example with Units

$$656.9888 = \frac{4 \cdot 3.1416 \cdot 17.5875\,\text{m}^2}{0.58\,\text{m}^2}$$

Variables used in list of Radar & Antenna Specifications Formulas above

- 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)*

Constants, Functions, Measurements used in list of Radar & Antenna Specifications Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[c]**, 299792458.0 *Light speed in vacuum*
- Functions: **log10**, log10(Number) *The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.*
- 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*

- ω_d Doppler Angular Frequency *(Radian per Second)*

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