Important Special Purpose Radars Formulas PDF

Formulas
Examples
with Units

List of 21
Important Special Purpose Radars Formulas

1) Amplitude of Reference Signal Formula

Evaluate Formula

Formula

$$A_{ref} = \frac{V_{ref}}{\sin\left(2 \cdot \pi \cdot \omega \cdot T\right)}$$

Example with Units

$$40.1971\,\text{V} = \frac{1.25\,\text{V}}{\sin\left(2 \cdot 3.1416 \cdot 99\,\text{rad/s} \cdot 50\,\mu\text{s}\right)}$$

2) Amplitude of Signal Received from Target at Range Formula

Evaluate Formula

Formula

$$A_{rec} = \frac{V_{echo}}{\sin\left(\left(2 \cdot \pi \cdot \left(f_c + \Delta f_d\right) \cdot T\right) - \left(\frac{4 \cdot \pi \cdot f_c \cdot R_o}{[c]}\right)\right)}$$

Example with Units

$$125.8165\,\text{V} = \frac{101.58\,\text{V}}{\sin\left(\left(2 \cdot 3.1416 \cdot \left(3000\,\text{Hz} + 20\,\text{Hz}\right) \cdot 50\,\mu\text{s}\right) - \left(\frac{4 \cdot 3.1416 \cdot 3000\,\text{Hz} \cdot 40000\,\text{m}}{3\text{E}+8\,\text{m/s}}\right)\right)}$$

3) CFA DC Power Input Formula

Evaluate Formula

Formula

$$P_{dc} = \frac{P_{out} - P_{drive}}{\eta_{cfa}}$$

Example with Units

$$27\,\text{W} = \frac{96.46\,\text{W} - 70\,\text{W}}{0.98}$$

4) CFA RF Drive Power Formula

Evaluate Formula

Formula

$$P_{drive} = P_{out} - \eta_{cfa} \cdot P_{dc}$$

Example with Units

$$70\,\text{W} = 96.46\,\text{W} - 0.98 \cdot 27\,\text{W}$$

5) CFA RF Power Output Formula

Evaluate Formula

Formula

$$P_{out} = \eta_{cfa} \cdot P_{dc} + P_{drive}$$

Example with Units

$$96.46\,\text{W} = 0.98 \cdot 27\,\text{W} + 70\,\text{W}$$

6) Distance from Antenna 1 to Target in Monopulse Radar Formula

Evaluate Formula

Formula

$$s_1 = \frac{R_o + s_a}{2} \cdot \sin(\theta)$$

Example with Units

$$17320.7029\,\text{m} = \frac{40000\,\text{m} + 0.45\,\text{m}}{2} \cdot \sin(60°)$$

7) Distance from Antenna 2 to Target in Monopulse Radar Formula

Evaluate Formula

Formula

$$s_2 = \frac{R_o - s_a}{2} \cdot \sin(\theta)$$

Example with Units

$$17320.3132\,\text{m} = \frac{40000\,\text{m} - 0.45\,\text{m}}{2} \cdot \sin(60°)$$

8) Doppler Frequency Shift Formula

Evaluate Formula

Formula

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

Example with Units

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

9) Echo Signal Voltage Formula

Evaluate Formula

Formula

$$V_{echo} = A_{rec} \cdot \sin\left(\left(2 \cdot \pi \cdot \left(f_c + \Delta f_d\right) \cdot T\right) - \left(\frac{4 \cdot \pi \cdot f_c \cdot R_o}{[c]}\right)\right)$$

Example with Units

$$101.7281\,\text{V} = 126\,\text{V} \cdot \sin\left(\left(2 \cdot 3.1416 \cdot \left(3000\,\text{Hz} + 20\,\text{Hz}\right) \cdot 50\,\mu\text{s}\right) - \left(\frac{4 \cdot 3.1416 \cdot 3000\,\text{Hz} \cdot 40000\,\text{m}}{3\text{E}{+}8\,\text{m/s}}\right)\right)$$

10) Efficiency of Cross Field Amplifier(CFA) Formula

Evaluate Formula

Formula

$$\eta_{cfa} = \frac{P_{out} - P_{drive}}{P_{dc}}$$

Example with Units

$$0.98 = \frac{96.46\,\text{W} - 70\,\text{W}}{27\,\text{W}}$$

11) Measured Position at Nth Scan Formula

Evaluate Formula

Formula

$$x_n = \left(\frac{X_{in} - x_{pn}}{\alpha}\right) + x_{pn}$$

Example with Units

$$6\,\text{m} = \left(\frac{40\,\text{m} - 74\,\text{m}}{0.5}\right) + 74\,\text{m}$$

12) Peak Quantization Lobe Formula

Evaluate Formula

Formula

$$Q_{max} = \frac{1}{2^{2 \cdot B}}$$

Example

$$0.1303 = \frac{1}{2^{2 \cdot 1.47}}$$

13) Phase Difference between Echo Signals in Monopulse Radar Formula

Evaluate Formula

Formula

$$\Delta_{\Phi} = 2 \cdot \pi \cdot s_a \cdot \frac{\sin(\theta)}{\lambda}$$

Example with Units

$$4.2218\,\text{rad} = 2 \cdot 3.1416 \cdot 0.45\,\text{m} \cdot \frac{\sin(60°)}{0.58\,\text{m}}$$

14) Position Smoothing Parameter Formula

Evaluate Formula

Formula

$$\alpha = \frac{X_{in} - x_{pn}}{x_n - x_{pn}}$$

Example with Units

$$0.5 = \frac{40\,\text{m} - 74\,\text{m}}{6\,\text{m} - 74\,\text{m}}$$

15) Predicted Position of Target Formula

Evaluate Formula

Formula

$$x_{pn} = \frac{X_{in} - (\alpha \cdot x_n)}{1 - \alpha}$$

Example with Units

$$74\,\text{m} = \frac{40\,\text{m} - (0.5 \cdot 6\,\text{m})}{1 - 0.5}$$

16) Range Resolution Formula

Evaluate Formula

Formula

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

Example with Units

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

17) Reference Voltage of CW Oscillator Formula

Evaluate Formula

Formula

$$V_{ref} = A_{ref} \cdot \sin(2 \cdot \pi \cdot \omega \cdot T)$$

Example with Units

$$1.25\,\text{V} = 40.197\,\text{V} \cdot \sin(2 \cdot 3.1416 \cdot 99\,\text{rad/s} \cdot 50\,\mu\text{s})$$

18) Smoothed Position Formula

Evaluate Formula

Formula

$$X_{in} = x_{pn} + \alpha \cdot (x_n - x_{pn})$$

Example with Units

$$40\,\text{m} = 74\,\text{m} + 0.5 \cdot (6\,\text{m} - 74\,\text{m})$$

19) Smoothed Velocity Formula

Evaluate Formula

Formula

$$v_s = v_{s(n-1)} + \frac{\beta}{T_s} \cdot (x_n - x_{pn})$$

Example with Units

$$9.3\,\text{m/s} = 11\,\text{m/s} + \frac{8}{320\,\text{s}} \cdot (6\,\text{m} - 74\,\text{m})$$

20) Time between Observations Formula

Evaluate Formula

Formula

$$T_s = \left(\frac{\beta}{v_s - v_{s(n-1)}}\right) \cdot (x_n - x_{pn})$$

Example with Units

$$320\,\text{s} = \left(\frac{8}{9.3\,\text{m/s} - 11\,\text{m/s}}\right) \cdot (6\,\text{m} - 74\,\text{m})$$

21) Velocity Smoothing Parameter Formula

Evaluate Formula

Formula

$$\beta = \left(\frac{v_s - v_{s(n-1)}}{x_n - x_{pn}} \right) \cdot T_s$$

Example with Units

$$8 = \left(\frac{9.3\,\text{m/s} - 11\,\text{m/s}}{6\,\text{m} - 74\,\text{m}} \right) \cdot 320\,\text{s}$$

Variables used in list of Special Purpose Radars Formulas above

- A_{rec} Amplitude of Signal Received *(Volt)*
- A_{ref} Amplitude of Reference Signal *(Volt)*
- **B** Mean Lobe
- f_c Carrier Frequency *(Hertz)*
- H_a Antenna Height *(Meter)*
- H_t Target Height *(Meter)*
- P_{dc} DC Power Input *(Watt)*
- P_{drive} CFA RF Drive Power *(Watt)*
- P_{out} CFA RF Power Output *(Watt)*
- Q_{max} Peak Quantization Lobe
- R_o Range *(Meter)*
- s_1 Distance from Antenna 1 to Target *(Meter)*
- s_2 Distance from Antenna 2 to Target *(Meter)*
- s_a Distance between Antennas in Monopulse Radar *(Meter)*
- **T** Time Period *(Microsecond)*
- T_s Time between Observations *(Second)*
- V_{echo} Echo Signal Voltage *(Volt)*
- V_{ref} CW Oscillator Reference Voltage *(Volt)*
- v_s Smoothed Velocity *(Meter per Second)*
- $v_{s(n-1)}$ (n-1)th Scan Smoothed Velocity *(Meter per Second)*
- v_t Target Velocity *(Meter per Second)*
- X_{in} Smoothed Position *(Meter)*
- x_n Measured Position at Nth Scan *(Meter)*
- x_{pn} Target Predicted Position *(Meter)*
- α Position Smoothing Parameter
- β Velocity Smoothing Parameter
- Δ_Φ Phase Difference between Echo Signals *(Radian)*
- Δf_d Doppler Frequency Shift *(Hertz)*
- ΔR Range Resolution *(Meter)*

Constants, Functions, Measurements used in list of Special Purpose Radars Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- constant(s): **[c]**, 299792458.0
  Light speed in vacuum
- Functions: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Microsecond (µs), Second (s)
  Time Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Angle** in Degree (°), Radian (rad)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Angular Frequency** in Radian per Second (rad/s)
  Angular Frequency Unit Conversion

- η_{cfa} Efficiency of Cross Field Amplifier
- θ Angle in Monopulse Radar *(Degree)*
- λ Wavelength *(Meter)*
- ω Angular Frequency *(Radian per Second)*

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