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Special Antennas Formulas

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List of 34 Special Antennas Formulas

Special Antennas

Array Antennas

1) Beam Width between First Null (BWFN) Broadside Array

Open Calculator

fx $$\mathrm{BWFN} = \frac{2 \cdot \lambda_{b}}{d \cdot N}$$

ex $$171.9064^{\circ} = \frac{2 \cdot 90.01\mathrm{m}}{10\mathrm{m} \cdot 6}$$

2) Beam Width between First Null (BWFN) Endside Array

Open Calculator

fx $$\mathrm{BW}_{\mathrm{end}} = 2 \cdot \sqrt{\frac{2 \cdot \lambda_{b}}{N \cdot d}}$$

ex $$198.4894^{\circ} = 2 \cdot \sqrt{\frac{2 \cdot 90.01\mathrm{m}}{6 \cdot 10\mathrm{m}}}$$

3) Field Pattern of Broadside Array

Open Calculator

fx $$E = \cos\left(\pi \cdot \frac{\cos(\Phi_{s})}{2}\right)$$

ex $$0.976199 = \cos\left(\pi \cdot \frac{\cos(278^{\circ})}{2}\right)$$

Helical Antennas

4) Axial Ratio of Helical Antenna

Open Calculator

fx $$\mathrm{AR} = \frac{(2 \cdot n) + 1}{2 \cdot n}$$

ex $$1.083195 = \frac{(2 \cdot 6.01) + 1}{2 \cdot 6.01}$$

5) Beam Width between First Null (BWFN) of Helical Antenna

Open Calculator

$$\mathrm{BW_{fn}} = 115 \cdot \frac{\mathrm{C}_{\lambda}^{\frac{3}{2}}}{\mathrm{C} \cdot \sqrt{\mathrm{S} \cdot \mathrm{n}}}$$

$$220.6484^{\circ} = 115 \cdot \frac{(0.8\mathrm{m})^{\frac{3}{2}}}{1.467\mathrm{m} \cdot \sqrt{35.3\mathrm{m} \cdot 6.01}}$$

6) Gain of Helical Antenna

Open Calculator

$$\mathrm{G_a} = 11.8 + 10 \cdot \log 10\left(\mathrm{C}_{\lambda}^{2} \cdot \mathrm{n} \cdot \mathrm{S}\right)$$

$$33.12829\mathrm{dB} = 11.8 + 10 \cdot \log 10\left((0.8\mathrm{m})^{2} \cdot 6.01 \cdot 35.3\mathrm{m}\right)$$

7) Half-Power Beamwidth of Helical Antenna

Open Calculator

$$\mathrm{B_{hp}} = \frac{52}{\mathrm{C}_{\lambda} \cdot \sqrt{\mathrm{n} \cdot \mathrm{S}}}$$

$$255.6886^{\circ} = \frac{52}{0.8\mathrm{m} \cdot \sqrt{6.01 \cdot 35.3\mathrm{m}}}$$

8) Helix Circumference of Helical Antenna

Open Calculator

$$\mathrm{C}_{\lambda} = \frac{\mathrm{Z_h}}{140}$$

$$0.8\mathrm{m} = \frac{112\Omega}{140}$$

9) Input Impedance of Helical Antenna

Open Calculator

$$\mathrm{Z_h} = 140 \cdot \mathrm{C}_{\lambda}$$

$$112\Omega = 140 \cdot 0.8\mathrm{m}$$

10) Pitch Angle of Helical Antenna

Open Calculator

$$\alpha = \arctan\left(\frac{S}{\pi \cdot H_d}\right)$$

$$48.30345° = \arctan\left(\frac{35.3\text{m}}{\pi \cdot 10.01\text{m}}\right)$$

Loop Antennas

11) Directivity of Large Loop

Open Calculator

$$D = 4.25 \cdot \frac{a}{\lambda_a}$$

$$0.377732 = 4.25 \cdot \frac{8\text{m}^2}{90.011\text{m}}$$

12) Efficiency Factor of Loop Antenna

Open Calculator

$$K = \frac{R_{small}}{R_{small} + R_L}$$

$$0.025552 = \frac{0.0118\Omega}{0.0118\Omega + 0.45\Omega}$$

13) Isotropic Radiation Intensity for Loop Antenna

Open Calculator

$$U_{ir} = \frac{U_r}{A_g}$$

$$0.09003\text{W/sr} = \frac{27.01\text{W/sr}}{300.01\text{dB}}$$

14) Quality Factor of Loop Antenna

Open Calculator

$$Q = \frac{X_L}{2 \cdot (R_L + R_{small})}$$

$$0.357298 = \frac{0.33\Omega}{2 \cdot (0.45\Omega + 0.0118\Omega)}$$

15) Radiation Resistance of Large Loop

Open Calculator

$$R_{large} = 3720 \cdot \frac{a}{\lambda_a}$$

$$330.6263\Omega = 3720 \cdot \frac{8m^2}{90.011m}$$

16) Radiation Resistance of Small Loop

Open Calculator

$$R_{small} = 31200 \cdot \frac{A^2}{\lambda_a^4}$$

$$0.011883\Omega = 31200 \cdot \frac{(5m^2)^2}{(90.011m)^4}$$

17) Size of Small Loop

Open Calculator

$$L = \frac{\lambda_a}{10}$$

$$9.0011m = \frac{90.011m}{10}$$

18) Terminal Resistance of Loop Antenna

Open Calculator

$$R_t = R_L + R_{small}$$

$$0.4618\Omega = 0.45\Omega + 0.0118\Omega$$

Microstrip Antenna

19) Actual Length of Microstrip Patch

Open Calculator

$$L_p = L_{eff} - 2 \cdot \Delta L$$

$$29.45397mm = 30.90426103mm - 2 \cdot 0.7251475831mm$$

20) Effective Dielectric Constant of Substrate

Open Calculator

$$E_{eff} = \frac{E_r + 1}{2} + \left(\frac{E_r - 1}{2}\right) \cdot \left(\frac{1}{\sqrt{1 + 12 \cdot \left(\frac{h}{W_p}\right)}}\right)$$

$$4.090057 = \frac{4.4 + 1}{2} + \left(\frac{4.4 - 1}{2}\right) \cdot \left(\frac{1}{\sqrt{1 + 12 \cdot \left(\frac{1.57\text{mm}}{38.01\text{mm}}\right)}}\right)$$

21) Effective Length of Patch

Open Calculator

$$L_{eff} = \frac{[c]}{2 \cdot f_{res} \cdot \left(\sqrt{E_{eff}}\right)}$$

$$30.88267\text{mm} = \frac{[c]}{2 \cdot 2.4\text{GHz} \cdot \left(\sqrt{4.09005704}\right)}$$

22) Effective Radius of Circular Microstrip Patch

Open Calculator

$$a_{eff} = a_c \cdot \left(1 + \left(\frac{2 \cdot h_o}{\pi \cdot a_c \cdot E_r}\right) \cdot \left(\ln\left(\frac{\pi \cdot a_c}{2 \cdot h_o} + 1.7726\right)\right)\right)^{0.5}$$

$$174.6228\text{cm} = 174.538\text{cm} \cdot \left(1 + \left(\frac{2 \cdot 0.157\text{cm}}{\pi \cdot 174.538\text{cm} \cdot 4.4}\right) \cdot \left(\ln\left(\frac{\pi \cdot 174.538\text{cm}}{2 \cdot 0.157\text{cm}} + 1.7726\right)\right)\right)^{0.5}$$

23) Height of Equilateral Triangular Patch

Open Calculator

$$H = \sqrt{S_{tng}^2 - \left(\frac{S_{tng}}{2}\right)^2}$$

$$34.40511\text{mm} = \sqrt{(39.7276\text{mm})^2 - \left(\frac{39.7276\text{mm}}{2}\right)^2}$$

24) Length Extention of Patch

Open Calculator

$$\Delta L = 0.412 \cdot h \cdot \left(\frac{(E_{eff} + 0.3) \cdot \left(\frac{W_p}{h} + 0.264 \right)}{(E_{eff} - 0.264) \cdot \left(\frac{W_p}{h} + 0.8 \right)} \right)$$

$$0.726285mm = 0.412 \cdot 1.57mm \cdot \left(\frac{(4.09005704 + 0.3) \cdot \left(\frac{38.01mm}{1.57mm} + 0.264 \right)}{(4.09005704 - 0.264) \cdot \left(\frac{38.01mm}{1.57mm} + 0.8 \right)} \right)$$

25) Length of Ground Plate

Open Calculator

$$L_{gnd} = 6 \cdot h + L_p$$

$$38.85mm = 6 \cdot 1.57mm + 29.43mm$$

26) Normalized Wavenumber

Open Calculator

$$F_n = \frac{8.791 \cdot 10^9}{f_{res} \cdot \sqrt{E_r}}$$

$$1.746227 = \frac{8.791 \cdot 10^9}{2.4GHz \cdot \sqrt{4.4}}$$

27) Physical Radius of Circular Microstrip Patch

Open Calculator

$$a_c = \frac{F_n}{\left(1 + \left(2 \cdot \frac{h_o}{\pi \cdot F_n \cdot E_r}\right) \cdot \left(\ln\left(\pi \cdot \frac{F_n}{2 \cdot h_o} + 1.7726\right)\right)\right)^{\frac{1}{2}}}$$

$$174.538cm = \frac{1.746227005}{\left(1 + \left(2 \cdot \frac{0.157cm}{\pi \cdot 1.746227005 \cdot 4.4}\right) \cdot \left(\ln\left(\pi \cdot \frac{1.746227005}{2 \cdot 0.157cm} + 1.7726\right)\right)\right)^{\frac{1}{2}}}$$

28) Radiation Resistance of Infinitesimal Dipole

Open Calculator

$$R_{isd} = 80 \cdot \pi^2 \cdot \left(\frac{l_{isd}}{\lambda_{isd}}\right)^2$$

$$0.315936\Omega = 80 \cdot \pi^2 \cdot \left(\frac{0.0024987m}{0.12491352m}\right)^2$$

29) Resonating Frequency of Equilateral Triangular Patch

Open Calculator

fx $$f_r = 2 \cdot \frac{[c]}{3 \cdot S_{tng} \cdot \sqrt{E_r}}$$

ex $$2.39834\text{GHz} = 2 \cdot \frac{[c]}{3 \cdot 39.7276\text{mm} \cdot \sqrt{4.4}}$$

30) Resonating Frequency of Microstrip Antenna

Open Calculator

fx $$f_r = \frac{[c]}{2 \cdot L_{eff} \cdot \sqrt{E_{eff}}}$$

ex $$2.398323\text{GHz} = \frac{[c]}{2 \cdot 30.90426103\text{mm} \cdot \sqrt{4.09005704}}$$

31) Side Length of Equilateral Triangular Patch

Open Calculator

fx $$S_{tng} = 2 \cdot \frac{[c]}{3 \cdot f_{res} \cdot \sqrt{E_r}}$$

ex $$39.70012\text{mm} = 2 \cdot \frac{[c]}{3 \cdot 2.4\text{GHz} \cdot \sqrt{4.4}}$$

32) Side Length of Hexagonal Patch

Open Calculator

fx $$S_{hex} = \frac{\sqrt{2 \cdot \pi} \cdot a_{eff}}{\sqrt{5.1962}}$$

ex $$192.1471\text{mm} = \frac{\sqrt{2 \cdot \pi} \cdot 17.47378\text{cm}}{\sqrt{5.1962}}$$

33) Width of Ground Plate

Open Calculator

fx $$W_{gnd} = 6 \cdot h + W_p$$

ex $$47.43\text{mm} = 6 \cdot 1.57\text{mm} + 38.01\text{mm}$$

34) Width of Microstrip Patch

Open Calculator

fx $$W_p = \frac{[c]}{2 \cdot f_{res} \cdot \left(\sqrt{\frac{E_r + 1}{2}} \right)}$$

ex $$38.00997\text{mm} = \frac{[c]}{2 \cdot 2.4\text{GHz} \cdot \left(\sqrt{\frac{4.4 + 1}{2}} \right)}$$

Variables Used

- **a** Area of Large Circular Loop *(Square Meter)*
- **A** Area of Small Circular Loop *(Square Meter)*
- a_c Actual Radius of Circular Microstrip Patch *(Centimeter)*
- a_{eff} Effective Radius of Circular Microstrip Patch *(Centimeter)*
- A_g Loop Antenna Gain *(Decibel)*
- **AR** Axial Ratio
- B_{hp} Half Power Beam Width *(Degree)*
- BW_{end} Beam Width between First Null Endside Array *(Degree)*
- BW_{fn} Helical Beam Width of First Null Broadside Array *(Degree)*
- **BWFN** Beam Width between First Null Broadside Array *(Degree)*
- **C** Operational Circumference *(Meter)*
- C_λ Helix Circumference *(Meter)*
- **d** Distance *(Meter)*
- **D** Directivity of Large Loop
- **E** Field Pattern
- E_{eff} Effective Dielectric Constant of Substrate
- E_r Dielectric Constant of Substrate
- F_n Normalized Wavenumber
- f_r Resonant Frequency *(Gigahertz)*
- f_{res} Frequency *(Gigahertz)*
- G_a Helical Antenna Gain *(Decibel)*
- **h** Thickness of the Substrate *(Millimeter)*
- **H** Height of Equilateral Triangular Patch *(Millimeter)*
- H_d Helix Diameter *(Meter)*
- h_o Thickness of Substrate Microstrip *(Centimeter)*
- **K** Efficiency Factor
- **L** Size of Small Loop *(Meter)*
- L_{eff} Effective Length of Microstrip Patch *(Millimeter)*
- L_{gnd} Length of Ground Plate *(Millimeter)*
- l_{isd} Length of Infinitesimal Dipole *(Meter)*

- **L_p** Actual Length of Microstrip Patch *(Millimeter)*
- **n** Number of Turns of Helical Antenna
- **N** Number of Turns of Array Antenna
- **Q** Quality Factor
- **R_{isd}** Radiation Resistance of Infinitesimal Dipole *(Ohm)*
- **R_L** Loss Resistance *(Ohm)*
- **R_{large}** Radiation Resistance of Large Loop *(Ohm)*
- **R_{small}** Radiation Resistance of Small Loop *(Ohm)*
- **R_t** Terminal Resistance of Loop Antenna *(Ohm)*
- **S** Turn Spacing *(Meter)*
- **S_{hex}** Side Length of Hexagonal Patch *(Millimeter)*
- **S_{tng}** Side Length of Equilateral Triangular Patch *(Millimeter)*
- **U_{ir}** Isotropic Radiation Intensity of Loop Antenna *(Watt per Steradian)*
- **U_r** Radiation Intensity in Loop Antenna *(Watt per Steradian)*
- **W_{gnd}** Width of Ground Plate *(Millimeter)*
- **W_p** Width of Microstrip Patch *(Millimeter)*
- **X_L** Inductive Reactance *(Ohm)*
- **Z_h** Input Impedance *(Ohm)*
- **α** Pitch Angle *(Degree)*
- **ΔL** Length Extension of Microstrip Patch *(Millimeter)*
- **λ_a** Wavelength in Loop Antenna *(Meter)*
- **λ_b** Broad Side Array Wavelength *(Meter)*
- **λ_{isd}** Wavelength of Dipole *(Meter)*
- **Φ_s** Phase Shift *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[c]**, 299792458.0 Meter/Second
  Light speed in vacuum
- Function: **arctan**, arctan(Number)
  Inverse trigonometric tangent function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **ctan**, ctan(Angle)
  Trigonometric cotangent function
- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- Function: **log10**, log10(Number)
  Common logarithm function (base 10)
- Function: **sqrt**, sqrt(Number)
  Square root function
- Function: **tan**, tan(Angle)
  Trigonometric tangent function
- Measurement: **Length** in Meter (m), Millimeter (mm), Centimeter (cm)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Gigahertz (GHz)
  Frequency Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Wavelength** in Meter (m)
  Wavelength Unit Conversion
- Measurement: **Sound** in Decibel (dB)
  Sound Unit Conversion
- Measurement: **Radiant Intensity** in Watt per Steradian (W/sr)
  Radiant Intensity Unit Conversion

Check other formula lists

- **Antenna Theory Parameters Formulas**
- **Wave Propagation Formulas**
- **Special Antennas Formulas**

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