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Electromagnetic Radiation and Antennas Formulas

Calculators! Examples! Conversions!

List of 13 Electromagnetic Radiation and Antennas Formulas

Electromagnetic Radiation and Antennas

1) Average Power

Open Calculator

fx $$P_r = \frac{1}{2} \cdot i_o^2 \cdot R_{rad}$$

ex $$67.8375W = \frac{1}{2} \cdot (4.5A)^2 \cdot 6.7\Omega$$

2) Average Power Density of Half-Wave Dipole

Open Calculator

fx $$[Pr]_{avg} = \frac{0.609 \cdot \eta_{hwd} \cdot I_o^2}{4 \cdot \pi^2 \cdot r_{hwd}^2} \cdot \sin\left(\left(\left(\left(W_{hwd} \cdot t\right) - \left(\frac{\pi}{L_{hwd}}\right) \cdot r_{hwd}\right)\right) \cdot \frac{\pi}{180}\right)^2$$

ex $$73.23764W/m^3 = \frac{0.609 \cdot 377\Omega \cdot (5A)^2}{4 \cdot \pi^2 \cdot (0.5m)^2} \cdot \sin\left(\left(\left((6.28e7rad/s \cdot 0.001s) - \left(\frac{\pi}{2m}\right) \cdot 0.5m\right)\right) \cdot \frac{\pi}{180}\right)^2$$

3) Directivity of Half-Wave Dipole

Open Calculator

fx $$D_{hwd} = \frac{[P]_{max}}{[Pr]_{avg}}$$

ex $$1.642053 = \frac{120.26W/m^3}{73.2376092W/m^3}$$

4) Electric Field for Hertzian Dipole

Open Calculator

fx $$E_\Phi = \eta \cdot H_\Phi$$

ex $$0.062961V/m = 9.3\Omega \cdot 6.77mA/m$$

5) Magnetic Field for Hertzian Dipole

Open Calculator

fx $$H_{\Phi} = \left(\frac{1}{r}\right)^2 \cdot \left(\cos\left(2 \cdot \pi \cdot \frac{r}{\lambda}\right) + 2 \cdot \pi \cdot \frac{r}{\lambda} \cdot \sin\left(2 \cdot \pi \cdot \frac{r}{\lambda}\right)\right)$$

ex $$6.773038\text{mA/m} = \left(\frac{1}{8.3\text{m}}\right)^2 \cdot \left(\cos\left(2 \cdot \pi \cdot \frac{8.3\text{m}}{20\text{m}}\right) + 2 \cdot \pi \cdot \frac{8.3\text{m}}{20\text{m}} \cdot \sin\left(2 \cdot \pi \cdot \frac{8.3\text{m}}{20\text{m}}\right)\right)$$

6) Maximum Power Density of Half-Wave Dipole

fx

Open Calculator

$$[P]_{max} = \frac{\eta_{hwd} \cdot I_o^2}{4 \cdot \pi^2 \cdot r_{hwd}^2} \cdot \sin\left(\left(\left(\left(W_{hwd} \cdot t\right) - \left(\frac{\pi}{L_{hwd}}\right) \cdot r_{hwd}\right)\right) \cdot \frac{\pi}{180}\right)^2$$

ex $$120.2588\text{W/m}^3 = \frac{377\Omega \cdot (5\text{A})^2}{4 \cdot \pi^2 \cdot (0.5\text{m})^2} \cdot \sin\left(\left(\left((6.28\text{e}7\text{rad/s} \cdot 0.001\text{s}) - \left(\frac{\pi}{2\text{m}}\right) \cdot 0.5\text{m}\right)\right) \cdot \frac{\pi}{180}\right)^2$$

7) Polarization

Open Calculator

fx $$P = X_e \cdot [\text{Permitivity-vacuum}] \cdot E$$

ex $$0.02124\text{C*cm}^2/\text{V} = 800 \cdot [\text{Permitivity-vacuum}] \cdot 300\text{V/m}$$

8) Power Radiated by Half-Wave Dipole

fx

Open Calculator

$$P_{rad} = \left(\frac{0.609 \cdot \eta_{hwd} \cdot (I_o)^2}{\pi}\right) \cdot \sin\left(\left(\left(W_{hwd} \cdot t\right) - \left(\left(\frac{\pi}{L_{hwd}}\right) \cdot r_{hwd}\right)\right) \cdot \frac{\pi}{180}\right)^2$$

ex

$$230.0828\text{W} = \left(\frac{0.609 \cdot 377\Omega \cdot (5\text{A})^2}{\pi}\right) \cdot \sin\left(\left((6.28\text{e}7\text{rad/s} \cdot 0.001\text{s}) - \left(\left(\frac{\pi}{2\text{m}}\right) \cdot 0.5\text{m}\right)\right) \cdot \frac{\pi}{180}\right)^2$$

9) Poynting Vector Magnitude

Open Calculator

fx $$S_r = \frac{1}{2} \cdot \left(\frac{I_d \cdot k \cdot d}{4 \cdot \pi}\right)^2 \cdot \eta \cdot (\sin(\theta))^2$$

ex $$12.43729\text{kW/m}^2 = \frac{1}{2} \cdot \left(\frac{23.4\text{A} \cdot 5.1 \cdot 6.4\text{m}}{4 \cdot \pi}\right)^2 \cdot 9.3\Omega \cdot (\sin(45\text{rad}))^2$$

10) Radiation Efficiency of Antenna

Open Calculator

fx $$\eta_r = \frac{G}{D_{max}}$$

ex $$3.03125 = \frac{9.7}{3.2}$$

11) Radiation Resistance of Antenna

Open Calculator

fx $$R_{rad} = 2 \cdot \frac{P_r}{i_o^2}$$

ex $$6.306173\Omega = 2 \cdot \frac{63.85\text{W}}{(4.5\text{A})^2}$$

12) Radiation Resistance of Half-Wave Dipole

Open Calculator

fx $$R_{hwd} = \frac{0.609 \cdot \eta_{hwd}}{\pi}$$

ex $$73.08172\Omega = \frac{0.609 \cdot 377\Omega}{\pi}$$

13) Time Average Radiated Power of Half-Wave Dipole

Open Calculator

fx $$(< P_{rad} \quad >) = \left(\frac{(I_o)^2}{2}\right) \cdot \left(\frac{0.609 \cdot \eta_{hwd}}{\pi}\right)$$

ex $$913.5215\text{W} = \left(\frac{(5\text{A})^2}{2}\right) \cdot \left(\frac{0.609 \cdot 377\Omega}{\pi}\right)$$

Variables Used

- $[P]_{max}$ Maximum Power Density *(Watt Per Cubic Meter)*
- $[Pr]_{avg}$ Average Power Density *(Watt Per Cubic Meter)*
- $< P_{rad} >$ Time Average Radiated Power *(Watt)*
- d Source Distance *(Meter)*
- D_{hwd} Directivity of Half Wave Dipole
- D_{max} Maximum Directivity
- E Electric Field Strength *(Volt per Meter)*
- E_{Φ} Electric Field Component *(Volt per Meter)*
- G Maximum Gain
- H_{Φ} Magnetic Field Component *(Milliampere per Meter)*
- I_d Dipole Current *(Ampere)*
- i_o Sinusoidal Current *(Ampere)*
- I_o Amplitude of Oscillating Current *(Ampere)*
- k Wavenumber
- L_{hwd} Length of Antenna *(Meter)*
- P Polarization *(Coulomb Square Centimeter per Volt)*
- P_r Average Power *(Watt)*
- p_{rad} Power Radiated by Half-wave Dipole *(Watt)*
- r Dipole Distance *(Meter)*
- r_{hwd} Radial Distance from Antenna *(Meter)*
- R_{hwd} Radiation Resistance of Half-wave Dipole *(Ohm)*
- R_{rad} Radiation Resistance *(Ohm)*
- S_r Poynting Vector *(Kilowatt per Square Meter)*
- t Time *(Second)*
- W_{hwd} Angular Frequency of Half Wave Dipole *(Radian per Second)*
- η Intrinsic Impedance *(Ohm)*
- η_{hwd} Intrinsic Impedance of Medium *(Ohm)*
- η_r Radiation Efficiency of Antenna
- θ Polar Angle *(Radian)*
- λ Dipole Wavelength *(Meter)*

- χ_e Electric Susceptibility

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[Permitivity-vacuum]**, 8.85E-12
  Permittivity of vacuum
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **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 Second (s)
  Time Unit Conversion
- Measurement: **Electric Current** in Ampere (A)
  Electric Current Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Wavelength** in Meter (m)
  Wavelength Unit Conversion
- Measurement: **Linear Current Density** in Milliampere per Meter (mA/m)
  Linear Current Density Unit Conversion
- Measurement: **Electric Field Strength** in Volt per Meter (V/m)
  Electric Field Strength Unit Conversion
- Measurement: **Heat Flux Density** in Kilowatt per Square Meter (kW/m^2)
  Heat Flux Density Unit Conversion
- Measurement: **Power Density** in Watt Per Cubic Meter (W/m^3)
  Power Density Unit Conversion
- Measurement: **Polarizability** in Coulomb Square Centimeter per Volt ($C*cm^2/V$)
  Polarizability Unit Conversion
- Measurement: **Angular Frequency** in Radian per Second (rad/s)
  Angular Frequency Unit Conversion

Check other formula lists

- **Electromagnetic Radiation and Antennas Formulas**

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