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Radio Wave Propagation Formulas

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List of 14 Radio Wave Propagation Formulas

Radio Wave Propagation

1) Distribution of Rain Attenuation

Open Calculator

fx $$PR = 1 + \left(\frac{2 \cdot L_G}{\pi \cdot D} \right)$$

ex $$34.39383\text{dB} = 1 + \left(\frac{2 \cdot 10.49098\text{km}}{\pi \cdot 0.2\text{km}} \right)$$

2) Earth Station Altitude

Open Calculator

fx $$h_o = h_{rain} - L_{slant} \cdot \sin(\angle \theta_{el})$$

ex $$199.9939\text{km} = 209.44\text{km} - 14.117\text{km} \cdot \sin(42^\circ)$$

3) Effective Path Length

Open Calculator

fx $$L_{eff} = \frac{A}{\alpha}$$

ex $$12\text{km} = \frac{360\text{dB}}{0.03\text{dB}}$$

4) Effective Path Length using Reduction Factor

Open Calculator

$$L_{eff} = L_{slant} \cdot r_p$$

$$11.99945\text{km} = 14.117\text{km} \cdot 0.85$$

5) Horizontal Projection of Slant Length

Open Calculator

$$L_G = L_{slant} \cdot \cos(\angle\theta_{el})$$

$$10.49098\text{km} = 14.117\text{km} \cdot \cos(42^\circ)$$

6) Plasma Frequency Terms of Electronic Density

Open Calculator

$$f_p = 9 \cdot \sqrt{N}$$

$$45\text{Hz} = 9 \cdot \sqrt{25\text{m}^3}$$

7) Rain Attenuation in Decibels

Open Calculator

$$A_p = \alpha \cdot R_p^b \cdot L_{slant} \cdot r_p$$

$$0.780338\text{dB} = 0.03\text{dB} \cdot (10\text{mm})^{1.332(\text{dB/km})/(\text{g/m}^3)} \cdot 14.117\text{km} \cdot 0.85$$

8) Rain Height

Open Calculator

$$h_{rain} = L_{slant} \cdot \sin(\angle\theta_{el}) + h_o$$

$$209.4461\text{km} = 14.117\text{km} \cdot \sin(42^\circ) + 200\text{km}$$

9) Reduction Factor using Slant Length

Open Calculator

fx $$r_p = \frac{L_{eff}}{L_{slant}}$$

ex $$0.850039 = \frac{12\text{km}}{14.117\text{km}}$$

10) Regression of Nodes

Open Calculator

fx $$n_{reg} = \frac{n \cdot SCOM}{a_{semi}^2 \cdot \left(1 - e^2\right)^2}$$

ex $$0.009044\text{rad/s}^2 = \frac{0.045\text{rad/s} \cdot 66063.2\text{km}^2}{(581.7\text{km})^2 \cdot \left(1 - (0.12)^2\right)^2}$$

11) Slant Length

Open Calculator

fx $$L_{slant} = \frac{L_{eff}}{r_p}$$

ex $$14.11765\text{km} = \frac{12\text{km}}{0.85}$$

12) Specific Attenuation

Open Calculator

fx $$\alpha = \frac{A}{L_{eff}}$$

ex $$0.03\text{dB} = \frac{360\text{dB}}{12\text{km}}$$

13) Specific Attenuation in Clouds or Fogs

Open Calculator

fx $$A_c = \frac{L \cdot b}{\sin(\angle\theta_{el})}$$

ex $$15.92514\text{dB} = \frac{8\text{kg} \cdot 1.332(\text{dB/km})/(\text{g/m}^3)}{\sin(42^\circ)}$$

14) Total Attenuation

Open Calculator

fx $$A = L_{eff} \cdot \alpha$$

ex $$360\text{dB} = 12\text{km} \cdot 0.03\text{dB}$$

Variables Used

- $\angle\theta_{el}$ Angle of Elevation *(Degree)*
- **A** Total Attenuation *(Decibel)*
- A_c Specific Attenuation due to Clouds *(Decibel)*
- A_p Rain Attenuation *(Decibel)*
- a_{semi} Semi Major Axis *(Kilometer)*
- **b** Specific Attenuation Coefficient *(Decibel per Kilometer per Gram per Cubic Meter)*
- **D** Diameter of Rain Cell *(Kilometer)*
- **e** Eccentricity
- f_p Plasma Frequency *(Hertz)*
- h_o Earth Station Altitude *(Kilometer)*
- h_{rain} Height of Rain *(Kilometer)*
- **L** Total Content of Liquid Water *(Kilogram)*
- L_{eff} Effective Path Length *(Kilometer)*
- L_G Horizontal Projection Length *(Kilometer)*
- L_{slant} Slant Length *(Kilometer)*
- **n** Mean Motion *(Radian per Second)*
- **N** Electron Density *(Cubic Meter)*
- n_{reg} Regression Node *(Radian per Square Second)*
- **PR** Distribution of Rain Attenuation *(Decibel)*
- r_p Reduction Factor
- R_p Rain Rate *(Millimeter)*

- **SCOM** SCOM Constant *(Square Kilometer)*
- **α** Specific Attenuation *(Decibel)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Kilometer (km), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Kilometer (km^2)
  Area Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Angular Velocity** in Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Sound** in Decibel (dB)
  Sound Unit Conversion
- Measurement: **Angular Acceleration** in Radian per Square Second (rad/s^2)

Angular Acceleration Unit Conversion

- Measurement: **Specific Attenuation Coefficient** in Decibel per Kilometer per Gram per Cubic Meter ((dB/km)/(g/m³))
  Specific Attenuation Coefficient Unit Conversion

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- **Geostationary Orbit Formulas**
- **Radio Wave Propagation Formulas**
- **Satellite Orbital Characteristics Formulas**

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