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Fiber Optic Communication Formulas

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List of 17 Fiber Optic Communication Formulas

Fiber Optic Communication

Optical Fiber Parameters

1) Diameter of Fiber

Open Calculator

fx $$d = \frac{\lambda \cdot N_M}{\pi \cdot NA}$$

ex $$25.90247\mu m = \frac{1.55\mu m \cdot 21}{\pi \cdot 0.4}$$

2) Fiber Attenuation Coefficient

Open Calculator

fx $$\alpha_p = \frac{\alpha}{4.343}$$

ex $$0.640111 = \frac{2.78dB}{4.343}$$

3) Fiber Length

Open Calculator

fx $$L = V_g \cdot T_d$$

ex $$1.25m = 2.5e8m/s \cdot 5e\text{-}9s$$

4) Gaussian Pulse

Open Calculator

fx $$\sigma_g = \frac{\sigma_\lambda}{L \cdot D}$$

ex $$5.3E\hat{}\text{-}18s/m = \frac{2e\text{-}11s}{1.25m \cdot 3e6s^2/m}$$

5) Number of Modes

Open Calculator

fx $$N_M = \frac{2 \cdot \pi \cdot r_{core} \cdot NA}{\lambda}$$

ex $$21.07907 = \frac{2 \cdot \pi \cdot 13\mu m \cdot 0.4}{1.55\mu m}$$

6) Number of Modes using Normalized Frequency

Open Calculator

fx $$N_M = \frac{V^2}{2}$$

ex $$21 = \frac{(6.48Hz)^2}{2}$$

7) Optical Dispersion

Open Calculator

fx $$D = \frac{2 \cdot \pi \cdot [c] \cdot \beta}{\lambda^2}$$

ex $$3E\hat{}6s^2/m = \frac{2 \cdot \pi \cdot [c] \cdot 3.8e\text{-}15rad/m}{(1.55\mu m)^2}$$

8) Power Loss in Fiber

Open Calculator

fx $P_{\alpha} = P_{in} \cdot \exp(\alpha_{p} \cdot L)$

ex $12.24048\text{W} = 5.5\text{W} \cdot \exp(0.64 \cdot 1.25\text{m})$

Wave Propagation Parameters

9) Graded Index Length of Fiber

Open Calculator

fx $n_{gr} = L \cdot \eta_{core}$

ex $1.66875 = 1.25\text{m} \cdot 1.335$

10) Group Delay

Open Calculator

fx $V_{g} = \frac{L}{T_{d}}$

ex $2.5\text{E}\hat{}8\text{m/s} = \frac{1.25\text{m}}{5\text{e-}9\text{s}}$

11) Normalized Frequency

Open Calculator

fx $V = \sqrt{2 \cdot N_{M}}$

ex $6.480741\text{Hz} = \sqrt{2 \cdot 21}$

12) Numerical Aperture

Open Calculator

fx $$\mathrm{NA} = \sqrt{\left(\eta_{\mathrm{core}}^2\right) - \left(\eta_{\mathrm{clad}}^2\right)}$$

ex $$0.402114 = \sqrt{\left((1.335)^2\right) - \left((1.273)^2\right)}$$

13) Optical Pulse Duration

Open Calculator

fx $$\sigma_\lambda = \mathrm{L} \cdot \mathrm{D} \cdot \sigma_{\mathrm{g}}$$

ex $$19.9875\mathrm{s} = 1.25\mathrm{m} \cdot 3\mathrm{e}6\mathrm{s}^2/\mathrm{m} \cdot 5.33\mathrm{e}\text{-}6\mathrm{s}/\mathrm{m}$$

14) Plane Wave Velocity

Open Calculator

fx $$\mathrm{V}_{\mathrm{plane}} = \frac{\omega}{\beta}$$

ex $$1\mathrm{E\^{}}17\mathrm{m/s} = \frac{390\mathrm{rad/s}}{3.8\mathrm{e}\text{-}15\mathrm{rad/m}}$$

15) Ray Optics Critical Angle

Open Calculator

fx $$\theta = \sin\left(\frac{\eta_{\mathrm{r}}}{\eta_{\mathrm{i}}}\right)^{-1}$$

ex $$64.34865^\circ = \sin\left(\frac{1.23}{1.12}\right)^{-1}$$

16) Refractive Index of Cladding

Open Calculator

fx $$\eta_{clad} = \sqrt{\eta_{core}^2 - NA^2}$$

ex $$1.273666 = \sqrt{(1.335)^2 - (0.4)^2}$$

17) Refractive Index of Fiber Core

Open Calculator

fx $$\eta_{core} = \sqrt{NA^2 + \eta_{clad}^2}$$

ex $$1.334365 = \sqrt{(0.4)^2 + (1.273)^2}$$

Variables Used

- **d** Diameter of Fiber *(Micrometer)*
- **D** Optical Fiber Dispersion *(Square Second per Meter)*
- **L** Length of Fiber *(Meter)*
- η_{gr} Grade Index Fiber
- N_M Number of Modes
- **NA** Numerical Aperture
- P_{in} Input Power *(Watt)*
- P_{α} Power Loss Fiber *(Watt)*
- r_{core} Radius of Core *(Micrometer)*
- T_d Group Delay *(Second)*
- **V** Normalized Frequency *(Hertz)*
- V_g Group Velocity *(Meter per Second)*
- V_{plane} Plane Wave Velocity *(Meter per Second)*
- α Attenuation Loss *(Decibel)*
- α_p Attenuation Coefficient
- β Propagation Constant *(Radian per Meter)*
- η_{clad} Refractive Index of Cladding
- η_{core} Refractive Index of Core
- η_i Refractive Index Incident Medium
- η_r Refractive Index Releasing Medium
- θ Critical Angle *(Degree)*
- λ Wavelength of Light *(Micrometer)*

- σ_g Gaussian Pulse *(Second per Meter)*
- σ_λ Optical Pulse Duration *(Second)*
- ω Angular Velocity *(Radian per Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[c]**, 299792458.0 Meter/Second
  Light speed in vacuum
- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Function: **exp**, exp(Number)
  Exponential function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Micrometer (µm), Meter (m)
  Length Unit Conversion
- Measurement: **Time** in 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 (°)
  Angle Unit Conversion
- Measurement: **Noise** in Decibel (dB)
  Noise Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion

- Measurement: **Angular Velocity** in Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Propagation Constant** in Radian per Meter (rad/m)
  Propagation Constant Unit Conversion
- Measurement: **Presement** in Second per Meter (s/m)
  Presement Unit Conversion
- Measurement: **Presity** in Square Second per Meter (s^2/m)
  Presity Unit Conversion

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