Modelli fisici di linee di trasmissione

Cavo coassiale
D = diametro calza
d = diametro cavo

$$C=\frac{2\pi\epsilon_0\epsilon_r}{\ln_e\left(\frac{D}{d}\right)} \quad L=\frac{\mu_0}{2\pi}\ln_e\left(\frac{D}{d}\right) \quad Z_\infty=\sqrt{\frac{\mu_0}{\epsilon_0\epsilon_r}}\cdot\frac{1}{2\pi}\ln_e\left(\frac{D}{d}\right)\approx\frac{60}{\sqrt{\epsilon_r}}\cdot\ln_e\left(\frac{D}{d}\right) \quad v_f=\frac{c}{\sqrt{\epsilon_r}} \quad f_{\text{max monomodale}}=\frac{v_f}{\pi(D+d)}$$

Linea bifilare
D = distanza tra i centri dei due fili
d = diametro di un filo

$$C=\frac{\pi\epsilon_0\epsilon_r}{\operatorname{arccosh}\left(\frac{D}{d}\right)} \quad L=\frac{\mu_0}{\pi}\operatorname{arccosh}\left(\frac{D}{d}\right) \quad Z_\infty=\sqrt{\frac{\mu_0}{\epsilon_0\epsilon_r}}\cdot\frac{1}{\pi}\operatorname{arccosh}\left(\frac{D}{d}\right)\approx\frac{120}{\sqrt{\epsilon_r}}\cdot\operatorname{arccosh}\left(\frac{D}{d}\right) \quad v_f=\frac{c}{\sqrt{\epsilon_r}}$$

$$\operatorname{arccosh}(x)=\log_e\left(1+\sqrt{x^2-1}\right)$$

Filo su piano metallico
Se il piano metallico è infinito o molto lungo, la linea è equivalente a una linea bifilare dove
d = diametro della filo
D = 2h, con h = distanza tra il piano e il centro del filo

Linea bifilare schermata (2 fili + 1 calza)
D = diametro della calza
d = diametro del filo
h = semi-distanza tra i centri dei due fili

$$C=\frac{\pi\epsilon_0\epsilon_r}{\ln_e\left(\frac{2h(D^2-h^2)}{d(D^2+h^2)}\right)} \quad L=\frac{\mu_0}{\pi}\cdot\ln_e\left(\frac{2h(D^2-h^2)}{d(D^2+h^2)}\right) \quad Z_\infty=\frac{1}{\pi}\cdot\sqrt{\frac{\mu_0}{\epsilon_0\epsilon_r}}\ln_e\left(\frac{2h(D^2-h^2)}{d(D^2+h^2)}\right) \quad v_f=\frac{c}{\sqrt{\epsilon_r}}$$

Stripeline
w = larghezza delle striscie
b = distanza tra le striscie

$$Z_\infty\approx\frac{30\pi}{\sqrt{\epsilon_r}}\cdot\frac{b}{w_{eff}+o.441b} \quad \frac{w_{eff}}{b}=\frac{w}{b}-\begin{cases}0 & \text{se } \frac{w}{b}>0.35\\ \left(0.35-\frac{w}{b}\right)^2 & \text{se } \frac{w}{b}<0.35\end{cases} \quad f=\frac{c}{\sqrt{\epsilon_r}}$$

Progetto: $\frac{w}{b}=\begin{cases}x & \text{se } \sqrt{\epsilon_r}\,Z_\infty<120\,\Omega\\ 0.85-\sqrt{0.6-x} & \text{se } \sqrt{\epsilon_r}\,Z_\infty>120\,\Omega\end{cases}$ con $x=\frac{30\pi}{\sqrt{\epsilon_r}\cdot Z_\infty}-0.441$

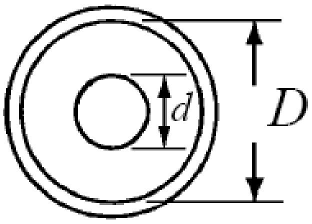
Microstriscia
w = ampiezza della microstriscia
h = distanza tra le due microstrisce

$$\epsilon_{eff}=\frac{\epsilon_r+1}{2}\left(1+\frac{1}{\sqrt{1+12\frac{h}{w}}}\right) \quad v_f=\frac{c}{\sqrt{\epsilon_{eff}}} \quad Z_\infty=\begin{cases}\frac{60}{\sqrt{\epsilon_{eff}}}\ln_e\left(\frac{8h}{w}+\frac{w}{4h}\right) & \text{se } \frac{w}{h}<1\\ \frac{120\pi}{\sqrt{\epsilon_{eff}}\left[\frac{w}{h}+1.393+0.667\ln_e\left(\frac{w}{h}+1.44\right)\right]} & \text{se } \frac{w}{h}>1\end{cases}$$

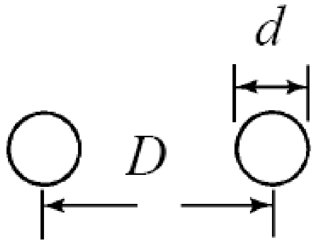
Progetto:

$$A=\frac{Z_\infty}{60}\cdot\sqrt{\frac{\varepsilon_r+1}{2}}+\frac{\varepsilon_r-1}{\varepsilon_r+1}\left(0,23+\frac{0,11}{\varepsilon_r}\right) \quad B=\frac{377\pi}{2Z_\infty\sqrt{\varepsilon_r}} \quad C=\ln(B-1)+0,39-\frac{0,61}{\varepsilon_r}$$

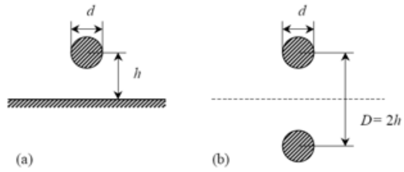
$$\frac{w}{h}=\begin{cases}\frac{8e^A}{e^{2A}-2} & \text{se } \frac{w}{h}<2\\ \frac{2}{\pi}\left[B-1-\ln(2B-1)+C\cdot\frac{\varepsilon_r-1}{2\varepsilon_r}\right] & \text{se } \frac{w}{h}>2\end{cases}$$



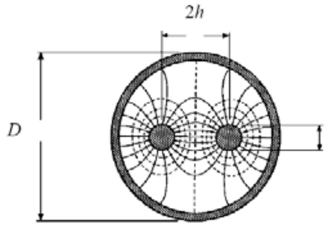
Cavo coassiale



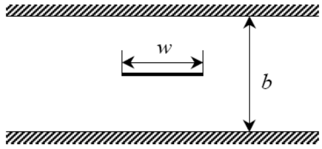
Linea bifilare



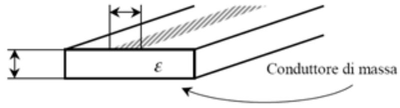
Filo su piano metallico



Linea bifilare schermata



Linea a striscia (stripeline)



Microstriscia