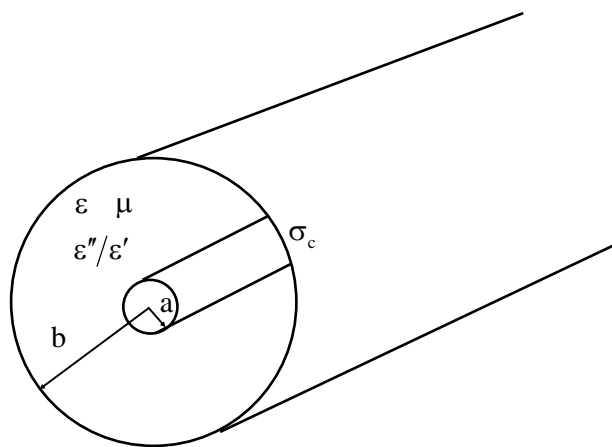


# LÍNEAS DE TRANSMISIÓN

## EJEMPLOS DE LÍNEAS DE TRANSMISIÓN

### Cable coaxial



# Cable coaxial

## Cable coaxial de bajas pérdidas

Impedancia característica:  $Z_0 = \sqrt{\frac{L}{C}}$

Constante de atenuación:  $\alpha = \underbrace{\frac{R}{2} \sqrt{\frac{C}{L}}}_{\alpha_c} + \underbrace{\frac{G}{2} \sqrt{\frac{L}{C}}}_{\alpha_d}$

Constante de fase:  $\beta = \omega \sqrt{LC}$

Velocidad de fase:  $v_\phi = \frac{1}{\sqrt{LC}}$

# Cable coaxial

Capacidad por unidad de longitud:  $C = \frac{2\pi\epsilon}{\ln\left(\frac{b}{a}\right)}$

Inductancia por unidad de longitud:  $L = \frac{\mu \ln\left(\frac{b}{a}\right)}{2\pi}$

Resistencia serie  
por unidad de longitud:

$$R = \frac{R_s}{2\pi} \left( \frac{1}{a} + \frac{1}{b} \right)$$

$$R_s = \frac{1}{\sigma_c \delta}$$

$$\delta = \sqrt{\frac{2}{\omega \mu_c \sigma_c}}$$

Conductancia paralelo  
por unidad de longitud:

$$G = \omega \frac{\epsilon''}{\epsilon'} C$$

## Cable coaxial

Impedancia característica:

$$Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{\mu}{\epsilon}} \frac{\ln\left(\frac{b}{a}\right)}{2\pi} = \eta \frac{\ln\left(\frac{b}{a}\right)}{2\pi}$$

Constante de fase:

$$\beta = \omega\sqrt{LC} = \omega\sqrt{\mu\epsilon}$$

Velocidad de fase:

$$v_\phi = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{\mu\epsilon}} = \frac{c}{\sqrt{\epsilon_r}}$$

## Cable coaxial

Constante de atenuación:  $\alpha = \frac{R}{2} \sqrt{\frac{C}{L}} + \frac{G}{2} \sqrt{\frac{L}{C}}$

Atenuación debida al conductor:

$$\alpha_c = \frac{1}{2\eta} \sqrt{\frac{\pi\mu_c f}{\sigma_c}} \left(\frac{1}{a} + \frac{1}{b}\right) \frac{1}{\ln\left(\frac{b}{a}\right)} \Rightarrow \boxed{\alpha_c \propto \sqrt{f}}$$

Atenuación debida al dieléctrico:

$$\alpha_d = \frac{\beta}{2} \frac{\epsilon''}{\epsilon'} = \frac{2\pi f \sqrt{\mu\epsilon}}{2} \frac{\epsilon''}{\epsilon'} \Rightarrow \boxed{\alpha_d \propto f}$$

Atenuación total:

$$\alpha = \alpha_c + \alpha_d = k_1 \sqrt{f} + k_2 f$$

# Cable coaxial

Mínimas pérdidas debidas al conductor:

$$\frac{b}{a} = 3,6 \quad \Rightarrow \quad Z_0 = 77 \Omega$$

Máxima potencia transmitida:

$$\frac{b}{a} = 1,65 \quad \Rightarrow \quad Z_0 = 30 \Omega$$

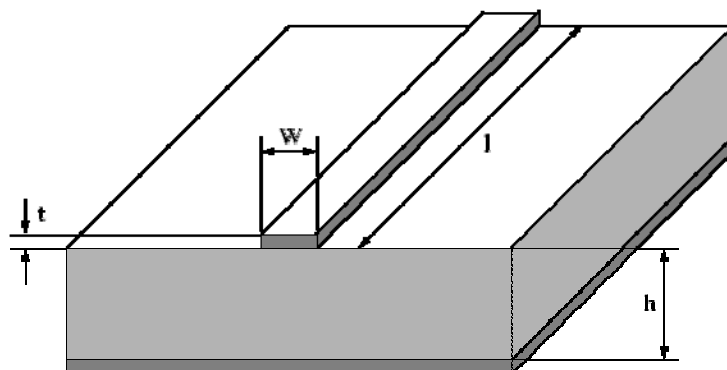
Solución de compromiso:

$$\frac{b}{a} = 2,3 \quad \Rightarrow \quad Z_0 = 50 \Omega$$

ECI Catalogue Number	Description	Nominal O.D. (inches)	Nominal Capacitance pF/ft	Nominal Impedance (Ohms)	Nominal % Velocity of Propagation	Nominal Attenuation	
						MHz	dB/100 ft
4032058FT1 4032058FT4	RG 58/U 20 AWG Solid Bare Copper Solid Polyethylene Dielectric 95% Tinned Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.195	28.5	53.5	66	50	3.1
						100	4.5
						200	6.8
						400	10.0
						700	14.0
900	16.0						
4032070FT1 4032070FT4	RG 58/U 20 AWG Solid Bare Copper Solid Polyethylene Dielectric 70% Tinned Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.195	28.5	53.5	66	50	3.1
						100	4.6
						200	6.3
						400	9.6
4022095FT1 4022095FT4	RG 58A/U 20/19 STC Foam Polyethylene Dielectric 95% Tinned Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.195	26.0	50	78	50	3.2
						100	4.5
						200	6.4
						400	9.5
4222095FT1 4222095FT4	RG 58C/U 20/19 STC Solid Polyethylene Dielectric 95% Tinned Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.195	30.8	50	66	50	4.1
						100	5.3
						200	8.2
						500	12.6
						900	20.0
4022093FT1 4022093FT4	RG 58/U Thinner 20/19 STC Foam Polyethylene Dielectric 100% Aluminum Foil Shield 93% Tinned Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.185	25.4	50	78	50	2.9
						100	4.2
						200	6.1
						400	8.9
						900	13.9

ECI Catalogue Number	Description	Nominal O.D. (inches)	Nominal Capacitance pF/ft	Nominal Impedance (Ohms)	Nominal % Velocity of Propagation	Nominal Attenuation	
						MHz	dB/100 ft
4002295FT1 4002295FT4	RG 59/U .0253" Copperweld Foam Polyethylene Dielectric 95% Bare Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.242	16.3	80	78	50 100 200 500 900	2.1 2.9 4.1 6.6 8.8
4012355FT1 4012355FT4	RG 59/U CATV .023" Copperweld Solid Polyethylene Dielectric Bonded Foil, 55% Aluminum Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.242	20.5	75	66	50 100 200 400	2.4 3.4 4.9 7.0
4012270FT1 4012270FT4	RG 59/U .0253" Copperweld Solid Polyethylene Dielectric 70% Bare Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.242	21.0	75	66	50 100 200 690	2.4 3.4 4.9 14.0
4012295FT1 4012295FT4	RG 59/U .0253" Copperweld Solid Polyethylene Dielectric 95% Bare Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.242	20.5	75	66	50 100 200 500 900	2.4 3.4 4.9 9.1 13.9
4122295FT1 4122295FT4	RG 59/U 22/7 Bare Copper Foam Polyethylene Dielectric 95% Bare Copper Braid PVC Jacket, CSA - UL Flame Rated FT-1 or FT-4	.242	16.3	75	78	50 100 200 500 900	2.1 3.0 4.5 7.4 10.1

## Línea microtira o microstrip



# Línea microtira o microstrip

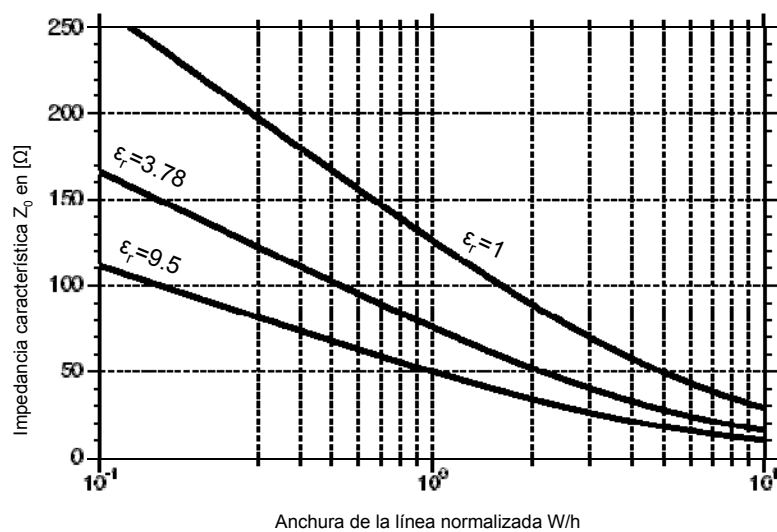
Constante dieléctrica efectiva:

$$\epsilon_{\text{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \cdot \frac{1}{\sqrt{1 + 12h/W}}$$

Impedancia característica:

$$Z_0 = \begin{cases} \frac{60}{\sqrt{\epsilon_{\text{eff}}}} \ln\left(\frac{8h}{W} + \frac{W}{4h}\right) & W/h \leq 1 \\ \frac{120\pi}{\sqrt{\epsilon_{\text{eff}} [W/h + 1,393 + 0,667 \ln(W/h + 1,444)]}} & W/h \geq 1 \end{cases}$$

# Línea microtira o microstrip



# Línea microtira o microstrip

