CUADRIPOLOS: PARÁMETROS

$$E_{IN} = I_{IN} * Z_{11} + I_{OUT} * Z_{12}$$

$$E_{OUT} = I_{IN} * Z_{21} + I_{OUT} * Z_{22}$$

PARÁMETROS	EXPRESA :	EN FUNCIÓN DE:
PARÁMETROS DE IMPEDANCIA "Z"	E_{IN} y E_{OUT}	I_{IN} y I_{OUT}
PARÁMETROS DE ADMITANCIA "Y"	I_{IN} y I_{OUT}	E_{IN} y E_{OUT}
PARÁMETROS HÍBRIDOS "h"	E_{IN} y I_{OUT}	I_{IN} y E_{OUT}
PARÁMETROS HÍBRIDOS "g"	I_{IN} y E_{OUT}	E_{IN} y I_{OUT}
PARÁMETROS DE TRANSMISIÓN DIRECTA "ABCD"	E_{IN} y I_{IN}	E_{OUT} y I_{OUT}
PARÁMETROS DE TRANSMISIÓN INVERSA "EFGH"	E_{OUT} y I_{OUT}	E_{IN} y I_{IN}

PARÁMETROS		Z	Y	ABCD	EFGH	h	g
Z	Z_{11}		$Y_{22} / \Delta Y$	A / C	h/G	$\Delta h/h_{22}$	$1/g_{11}$
	Z_{12}		$-Y_{12} / \Delta Y$	$(AD-BC)/C$	$1/G$	h_{12}/h_{22}	$-g_{12}/g_{11}$
	Z_{21}		$-Y_{21} / \Delta Y$	$1 / C$	$(EH-GF)/G$	$-h_{21}/h_{22}$	g_{21}/g_{11}
	Z_{22}		$Y_{11} / \Delta Y$	D / C	E/G	$1/h_{22}$	$\Delta g/g_{11}$
	ΔZ	$Z_{11}Z_{22}-Z_{12}Z_{21}$	$1 / \Delta Y$	B / C	F/G	h_{11}/h_{22}	g_{22}/g_{11}
Y	Y_{11}	$Z_{22} / \Delta Z$		D/B	E/F	$1/h_{11}$	$\Delta g/g_{22}$
	Y_{12}	$-Z_{12} / \Delta Z$		$-(AD-BC)/B$	$-1/F$	$-h_{12}/h_{11}$	g_{12}/g_{22}
	Y_{21}	$-Z_{21} / \Delta Z$		$-1/B$	$-(EH-GF)/F$	h_{21}/h_{11}	$-g_{21}/g_{22}$
	Y_{22}	$Z_{11} / \Delta Z$		A/B	H/F	$\Delta h/h_{11}$	$1/g_{22}$
	ΔY	$1 / \Delta Z$	$Y_{11}Y_{22}-Y_{12}Y_{21}$	C/B	G/F	h_{22}/h_{11}	g_{11}/g_{22}
ABCD	A	Z_{11} / Z_{21}	$-Y_{22}/Y_{21}$		$H/(H-GF)$	$-\Delta h/h_{21}$	$1/g_{21}$
	B	$\Delta Z / Z_{21}$	$-1/Y_{21}$		$F/(EH-GF)$	$-h_{11}/h_{21}$	g_{22}/g_{21}
	C	$1 / Z_{21}$	$-\Delta Y/Y_{21}$		$G/(EH-GF)$	$-h_{22}/h_{21}$	g_{11}/g_{21}
	D	Z_{22} / Z_{21}	$-Y_{11}/Y_{21}$		$E/(EH-GF)$	$-1/h_{21}$	$\Delta g/g_{21}$
	Δ_{ABCD}	Z_{12} / Z_{21}	Y_{12}/Y_{21}	$(AD-BC)=1$	$1/(EH-GF)$	$-h_{12}/h_{21}$	$-g_{12}/g_{21}$
EFGH	E	Z_{22} / Z_{12}	$-Y_{11}/Y_{12}$	$D/(AD-BC)$		$1/h_{12}$	$-\Delta g/g_{12}$
	F	$\Delta Z / Z_{12}$	$-1/Y_{12}$	$B/(AD-BC)$		h_{11}/h_{12}	$-g_{22}/g_{12}$
	G	$1 / Z_{12}$	$-\Delta Y/Y_{12}$	$C/(AD-BC)$		h_{22}/h_{12}	$-g_{11}/g_{12}$
	H	Z_{11} / Z_{12}	$-Y_{22}/Y_{12}$	$A/(AD-BC)$		$\Delta h/h_{12}$	$-1/g_{12}$
	Δ_{EFGH}	Z_{12} / Z_{12}	Y_{21}/Y_{12}	$1/(AD-BC)$	$(EH-FG)=1$	$-h_{21}/h_{12}$	$-g_{21}/g_{12}$
H	h_{11}	$\Delta Z/ Z_{22}$	$1/Y_{11}$	B/D	F/E		$g_{22}/\Delta g$
	h_{12}	Z_{12}/ Z_{22}	$-Y_{12}/Y_{11}$	$(AD-BC)/D$	$1/E$		$-g_{12}/\Delta g$
	h_{21}	$-Z21/ Z_{22}$	Y_{21}/Y_{11}	$-1/D$	$-(EH-GF)/E$		$-g_{21}/\Delta g$
	h_{22}	$1/ Z_{22}$	$\Delta Y/Y_{11}$	C/D	G/E		$g_{11}/\Delta g$
	Δh	Z_{11}/ Z_{22}	Y_{22}/Y_{11}	A/D	H/E	$h_{11}h_{22}-h_{12} h_{21}$	$1/\Delta g$
G	g_{11}	$1/ Z_{11}$	$\Delta Y/Y_{22}$	C/A	G/H	$h_{22}/\Delta h$	
	g_{12}	$-Z_{12}/ Z_{11}$	Y_{12}/Y_{22}	$-(AD-BC)/A$	$-1/H$	$-h_{12}/\Delta h$	
	g_{21}	Z_{21}/ Z_{11}	$-Y_{21}/Y_{22}$	$1/A$	$(EH-FG)/H$	$-h_{21}/\Delta h$	
	g_{22}	$\Delta Z/ Z_{11}$	$1/Y_{22}$	B/A	F/H	$h_{11}/\Delta h$	
	Δg	Z_{22}/ Z_{11}	Y_{11}/Y_{22}	D/A	E/H	$1/\Delta h$	$g_{11}g_{22}-g_{12} g_{21}$

PARÁMETROS DE IMPEDANCIA Z

$$Z_{11}=\left.\frac{E_{IN}}{I_{IN}}\right|_{I_{OUT}=0}\qquad Z_{12}=\left.\frac{E_{IN}}{I_{OUT}}\right|_{I_{IN}=0}$$

$$Z_{21}=\left.\frac{E_{OUT}}{I_{IN}}\right|_{I_{OUT}=0}\qquad Z_{22}=\left.\frac{E_{OUT}}{I_{OUT}}\right|_{I_{IN}=0}$$

PARÁMETROS DE ADMITANCIA Y

$$Y_{11}=\left.\frac{I_{IN}}{E_{IN}}\right|_{E_{OUT}=0}\qquad Y_{12}=\left.\frac{I_{IN}}{E_{OUT}}\right|_{E_{IN}=0}$$

$$Y_{21}=\left.\frac{I_{OUT}}{E_{IN}}\right|_{E_{OUT}=0}\qquad Y_{22}=\left.\frac{I_{OUT}}{E_{OUT}}\right|_{E_{IN}=0}$$

PARÁMETROS DE TRANSMISIÓN DIRECTA ABCD

$$A=\frac{Z_{11}}{Z_{21}}=\left.\frac{E_{IN}}{E_{OUT}}\right|_{I_{OUT}=0}\qquad B=\frac{\Delta z}{Z_{21}}=\left.\frac{E_{IN}}{I_{OUT}}\right|_{E_{OUT}=0}$$

$$C=\frac{1}{Z_{21}}=\left.\frac{I_{IN}}{E_{OUT}}\right|_{I_{OUT}=0}\qquad D=\frac{Z_{22}}{Z_{21}}=\left.\frac{I_{IN}}{I_{OUT}}\right|_{E_{OUT}=0}$$

PARÁMETROS DE TRANSMISIÓN INVERSA EFGH

$$E=\frac{Z_{22}}{Z_{12}}=\left.\frac{E_{OUT}}{E_{IN}}\right|_{I_{IN}=0}\qquad F=\frac{\Delta z}{Z_{12}}=\left.\frac{E_{OUT}}{I_{IN}}\right|_{E_{IN}=0}$$

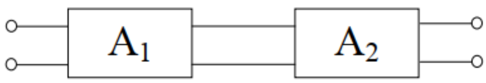
$$G=\frac{1}{Z_{12}}=\left.\frac{I_{OUT}}{E_{IN}}\right|_{I_{IN}=0}\qquad H=\frac{Z_{11}}{Z_{12}}=\left.\frac{I_{OUT}}{I_{IN}}\right|_{E_{IN}=0}$$

De los parámetros de transmisión directa e inversa:

$$A=H=\frac{Z_{11}}{Z_{12}}\qquad B=F=\frac{\Delta z}{Z_{12}}\qquad C=G=\frac{1}{Z_{12}}\qquad D=E=\frac{Z_{22}}{Z_{12}}$$

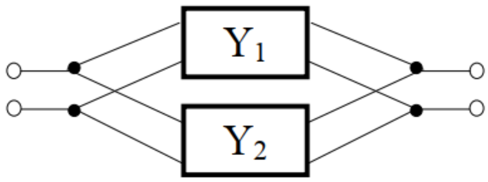
$$\Delta_{ABCD}=\Delta_{EFGH}=1$$

CONEXIÓN EN CASCADA



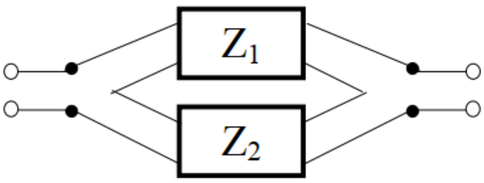
$$A_T=A_1*A_2$$

CONEXIÓN EN PARALELO



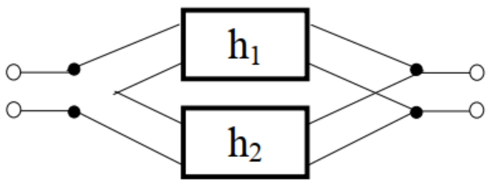
$$Y_T=Y_1+Y_2$$

CONEXIÓN EN SERIE



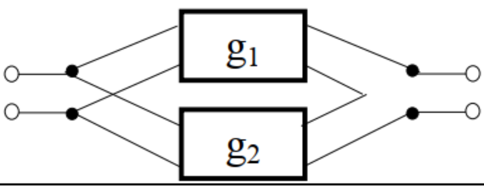
$$Z_T=Z_1+Z_2$$

CONEXIÓN SERIE-PARALELO



$$h_T=h_1+h_2$$

CONEXIÓN PARALELO-SERIE

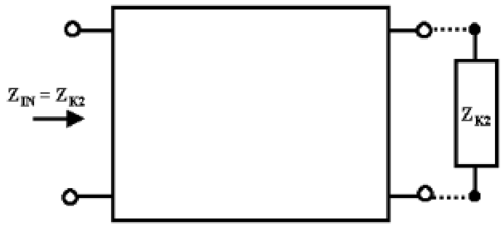


$$g_T=g_1+g_2$$

IMPEDANCIA ITERATIVA

Se carga solo uno de los extremos del cuadripolo. Cuando se carga un cuadripolo con su impedancia iterativa de entrada, el mismo valor se obtiene como impedancia de salida y si se carga con su impedancia iterativa de salida, el mismo valor se obtiene como impedancia de entrada.

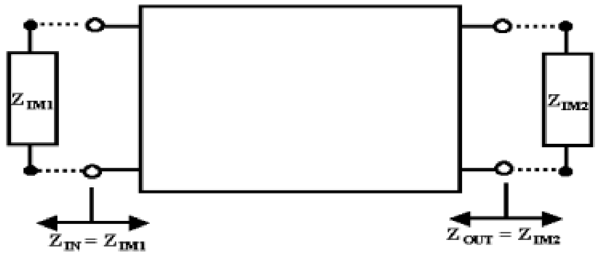
$$\boxed{\begin{aligned} Z_{K1} &= \frac{-(A-D)}{2C} \pm \sqrt{\left[\frac{(A-D)}{2C}\right]^2 + \frac{B}{C}} \\ Z_{K2} &= \frac{-(D-A)}{2C} \pm \sqrt{\left[\frac{(D-A)}{2C}\right]^2 + \frac{B}{C}} \end{aligned}}$$



IMPEDANCIA IMAGEN

Se cargan ambos extremos del cuadripolo simultáneamente.

$$\boxed{Z_{IM\,1} = \sqrt{\frac{A * B}{C * D}}}$$



$$\boxed{Z_{IM\,2} = \sqrt{\frac{B * D}{A * C}}}$$

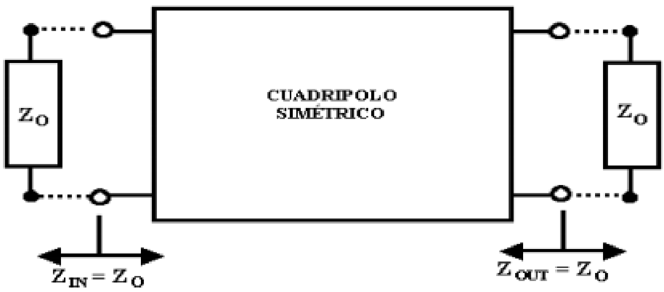
IMPEDANCIA CARACTERÍSTICA

Se produce en cuadripolos simétricos. Partiendo de la impedancia imagen podemos obtener la impedancia característica.

$$Z_O = \sqrt{\frac{A * B}{C * D}} = \sqrt{\frac{B * D}{A * C}}$$

Pero A = D pues $Z_{11}=Z_{22}$, por lo tanto:

$$\boxed{Z_O = \sqrt{\frac{B}{C}}}$$



Se puede verificar idéntico resultado a partir de las expresiones de impedancia iterativa en un cuadripolo simétrico donde A = D.

$$Z_{K1} = \frac{-\cancel{(A-D)}^{\,0}}{2C} \pm \sqrt{\left[\frac{\cancel{(A-D)}^{\,0}}{2C}\right]^2 + \frac{B}{C}} = \sqrt{\frac{B}{C}} \qquad Z_{K2} = \frac{-\cancel{(D-A)}^{\,0}}{2C} \pm \sqrt{\left[\frac{\cancel{(D-A)}^{\,0}}{2C}\right]^2 + \frac{B}{C}} = \sqrt{\frac{B}{C}}$$

FUNCIONES DE PROPAGACIÓN

Todas parten de:

$$\frac{E_{IN}}{E_{OUT}} = A + \frac{B}{Z_{OUT}} \qquad \frac{I_{IN}}{I_{OUT}} = C * Z_{OUT} + D$$

Para $Z_{OUT} = Z_{K2}$

$$\left|\frac{I_{IN}}{I_{OUT}}\right|_{Z_{K2}} = \left|\frac{E_{IN}}{E_{OUT}}\right|_{Z_{K2}} = \frac{(A+D)}{2} + \sqrt{\left[\frac{(A+D)}{2}\right]^2 - 1} = \cosh\ \gamma + senh\,\gamma = e^{\gamma} = e^{\alpha+j\beta} = e^{\alpha} \times e^{j\beta}$$

Para $Z_{OUT} = Z_{IM2}$

$$\left|\frac{E_{IN}}{E_{OUT}}\right|_{Z_{IM2}} = \sqrt{\frac{Z_{im1}}{Z_{im2}}} \times \left[\sqrt{A \times D} + \sqrt{(A \times D) - 1)}\right] = \sqrt{\frac{Z_{im1}}{Z_{im2}}} \times (\cosh\ \theta + senh\,\theta) = e^{\gamma}$$

Para $Z_{OUT} = Z_{IM2}$

$$\left|\frac{I_{IN}}{I_{OUT}}\right|_{Z_{IM2}} = \sqrt{\frac{Z_{im2}}{Z_{im1}}} \times \left[\sqrt{A \times D} + \sqrt{(A \times D) - 1)}\right] = \sqrt{\frac{Z_{im2}}{Z_{im1}}} \times (\cosh\ \theta + senh\,\theta) = e^{\gamma}$$

Para $Z_{OUT} = Z_O$ ó para el caso de un cuadripolo simétrico, dado que $A = D$ y $Z_{IM1} = Z_{IM2} = Z_O$, todos los casos se reducen a :

$$\frac{I_{IN}}{I_{OUT}} = \frac{E_{IN}}{E_{OUT}} = A + \sqrt{A^2 - 1} = (\cosh\ \gamma + senh\,\gamma) = e^{\gamma} = e^{\alpha+j\beta} = e^{\alpha} \times e^{j\beta}$$

γ es la constante de propagación.

α es la constante de atenuación que se mide en [neper] .

β es la constante de fase. cuadripolo es resistivo puro $\beta = 0$.

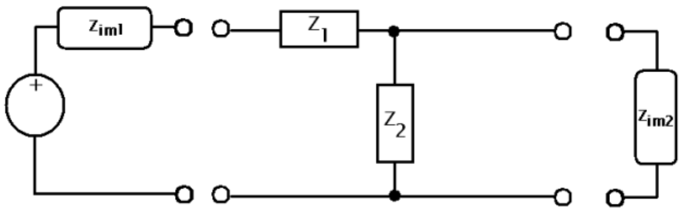
en caso de ser resistivo puro:

$$\frac{E_{IN}}{E_{OUT}} = veces \qquad \gamma = \ln\left[\frac{E_{IN}}{E_{OUT}}\right] = neper \qquad \gamma = 20 \log_{10}\left[\frac{E_{IN}}{E_{OUT}}\right] = dB$$

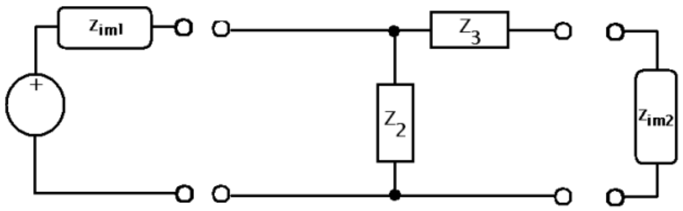
CUADRIPOLOS ADAPTADORES DE IMPEDANCIA

$A = \sqrt{\frac{Zim1}{Zim2}} \bullet \cosh\theta$	$B = \sqrt{Zim1 \bullet Zim2} \bullet senh\theta$
$C = \frac{senh\theta}{\sqrt{Zim1 \bullet Zim2}}$	$D = \sqrt{\frac{Zim2}{Zim1}} \bullet \cosh\theta$

CUADRIPOLO TIPO "L"



$Z_{im1} > Z_{im2}$



$Z_{im1} < Z_{im2}$

Caso Zim1 > Zim2

$$A = \frac{Z_{11}}{Z_{21}} = \frac{Z1+Z2}{Z2} = \sqrt{\frac{Zim1}{Zim2}} \bullet \cosh\theta \quad \therefore \quad Z1 = \left(\sqrt{\frac{Zim1}{Zim2}} \bullet \cosh\theta * Z2\right) - Z2 \qquad [15]$$

$$B = \frac{\Delta_Z}{Z_{21}} = \frac{(Z1+Z2)\bullet Z2 - Z2^2}{Z2} = Z1 = \sqrt{Zim1 \bullet Zim2} \bullet senh\theta$$

$$\therefore \quad Z1 = \sqrt{Zim1 \bullet Zim2} \bullet senh\theta \qquad [16]$$

$$C = \frac{1}{Z_{21}} = \frac{1}{Z2} = \frac{senh\theta}{\sqrt{Zim1 \bullet Zim2}} \quad \therefore \quad Z2 = \frac{\sqrt{Zim1 \bullet Zim2}}{senh\theta} \qquad [17]$$

$$D = \frac{Z_{22}}{Z_{21}} = \frac{Z2}{Z2} = 1 = \sqrt{\frac{Zim2}{Zim1}} \bullet \cosh\theta \quad \therefore \quad \theta = \cosh^{-1}\left(\sqrt{\frac{Zim1}{Zim2}}\right) \qquad [18]$$

$$\frac{E_{IN}}{E_{OUT}} = \sqrt{\frac{Zim1}{Zim2}} \bullet e^{\theta} \qquad [19]$$

Caso Zim1 > Zim2

$$A=\frac{Z_{11}}{Z_{21}}=\frac{Z2}{Z2}=1=\sqrt{\frac{Zim1}{Zim2}}\bullet\cosh\theta \quad \therefore \quad \theta=\cosh^{-1}\left(\sqrt{\frac{Zim2}{Zim1}}\right) \qquad [19]$$

$$B=\frac{\Delta_Z}{Z_{21}}=\frac{Z_{11}\bullet Z_{22}-Z_{21}{}^2}{Z_{21}}=\frac{Z2\bullet(Z2+Z3)-Z2^2}{Z2}=Z3=\sqrt{Zim1\bullet Zim2}\bullet senh\theta$$

$$\therefore \quad Z3=\sqrt{Zim1\bullet Zim2}\bullet senh\theta \qquad [20]$$

$$C=\frac{1}{Z_{21}}=\frac{1}{Z2}=\frac{senh\theta}{\sqrt{Zim1\bullet Zim2}} \quad \therefore \quad Z2=\frac{\sqrt{Zim1\bullet Zim2}}{senh\theta} \qquad [21]$$

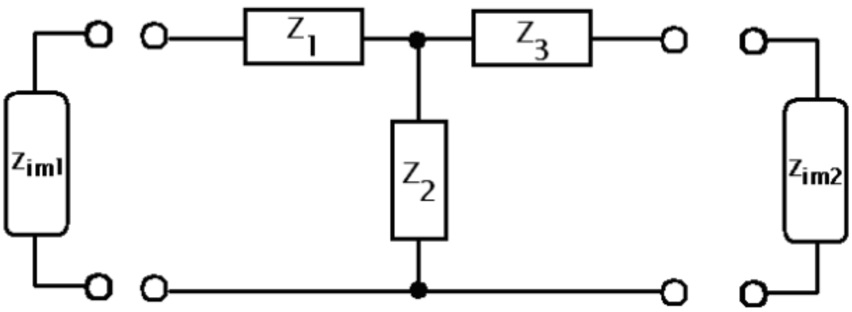
$$D=\frac{Z_{22}}{Z_{21}}=\frac{Z2+Z3}{Z2}=\sqrt{\frac{Zim2}{Zim1}}\bullet\cosh\theta \quad \therefore \quad Z3=\left(\sqrt{\frac{Zim2}{Zim1}}\bullet\cosh\theta * Z2\right)-Z2 \qquad [22]$$

$$\frac{E_{IN}}{E_{OUT}}=\sqrt{\frac{Zim1}{Zim2}}\bullet e^{\theta} \qquad [23]$$

CUADRIPOLO TIPO "T"

$$Z1=\frac{Zim1\bullet\cosh\theta-\sqrt{Zim1\bullet Zim2}}{senh\theta}$$

$$Z3=\frac{Zim2\bullet\cosh\theta-\sqrt{Zim1\bullet Zim2}}{senh\theta}$$



$$Z2=\frac{\sqrt{Zim1\bullet Zim2}}{senh\,\theta}$$

$$\theta=\cosh^{-1}\left(\sqrt{\frac{Zim1}{Zim2}}\right) \quad si \quad Zim1 > Zim2 \qquad y \qquad \theta=\cosh^{-1}\left(\sqrt{\frac{Zim2}{Zim1}}\right) \quad si \quad Zim1 < Zim2$$

$$\frac{Ein}{Eout}=\sqrt{\frac{Zim1}{Zim2}}\bullet e^{\theta} \qquad \text{Recordemos ademas que} \quad \frac{Ein}{Eout}=\sqrt{\frac{Zim1}{Zim2}}\bullet e^{a+jb}=\sqrt{\frac{Zim1}{Zim2}}\bullet e^{a}\bullet e^{jb}$$

Si **Zim1>Zim2 → Z3=0** o si **Zim1<Zim2 → Z1=0** entonces se debe aumentar el valor de Ein/Eout y recalcular theta:

$$\theta=Ln\left(\left[\frac{Ein}{Eout}\right]_{RECALCULADO}\bullet\sqrt{\frac{Zim2}{Zim1}}\right)=a+jb$$

$$a=Ln\left\|\left(\left[\frac{Ein}{Eout}\right]_{RECALCULADO}\bullet\sqrt{\frac{Zim2}{Zim1}}\right)\right\| \qquad Func.Atenuación\ ALFA_{BASE\ IMAGEN} \qquad [29]$$

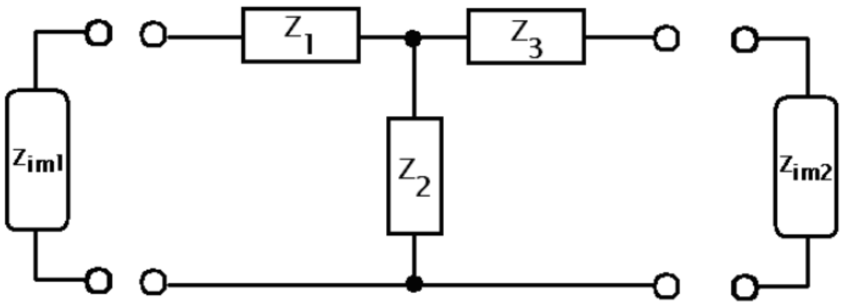
$$b=tg^{-1}\left[\frac{\mathrm{Im}\left(\left[\frac{Ein}{Eout}\right]_{RECALCULADO}\bullet\sqrt{\frac{Zim2}{Zim1}}\right)}{\mathrm{Re}\left(\left[\frac{Ein}{Eout}\right]_{RECALCULADO}\bullet\sqrt{\frac{Zim2}{Zim1}}\right)}\right] \qquad Fun.\ Fase\ BETA_{BASE\ IMAGEN} \qquad [30]$$

CUADRIPOLOS ATENUADORES

CUADRIPOLO SIMÉTRICO TIPO “T” RESISTIVO PURO

$$Z1 = \frac{Zim1 \bullet \cosh\theta - \sqrt{Zim1 \bullet Zim2}}{senh\,\theta} \quad [26]$$

$$Z3 = \frac{Zim2 \bullet \cosh\theta - \sqrt{Zim1 \bullet Zim2}}{senh\,\theta} \quad [28]$$



$$Z2 = \frac{\sqrt{Zim1 \bullet Zim2}}{senh\,\theta} \quad [25]$$

Al ser simétrico: $Z1 = Z3$ $Z_{11} = Z_{22}$ $A = D$ por lo que:

$$Zo = Zim1 = Zim2 = \sqrt{\frac{B}{C}}$$

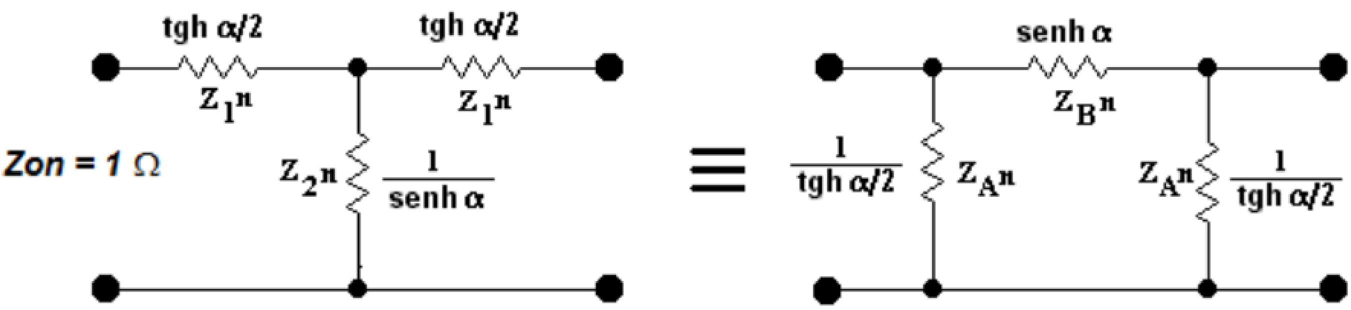
luego:

$$Z1 = Z3 = \frac{Zo \bullet \cosh\alpha - Zo}{senh\,\alpha} \qquad Z2 = \frac{Zo}{senh\,\alpha}$$

Si se toma una carga Zon se deberá multiplicar Z1 y Z2 para desnormalizar. Con Zon = 1:

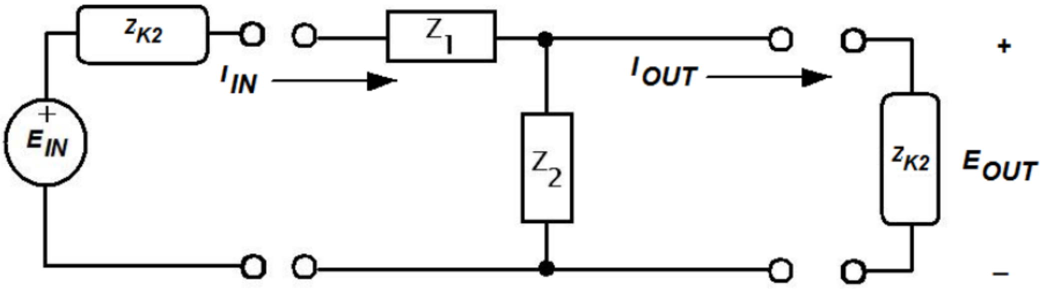
$$\boxed{Z1n = Z3n = \frac{\cosh\alpha - 1}{senh\,\alpha} = tgh\frac{\alpha}{2}}$$

$$\boxed{Z2n = \frac{Zon}{senh\,\alpha} = \frac{1}{senh\,\alpha}}$$



$$Z_{\#} = Z_{\#n} * Ro\ [\Omega]$$

CUADRIPOLO SIMÉTRICO TIPO "L" RESISTIVO PURO



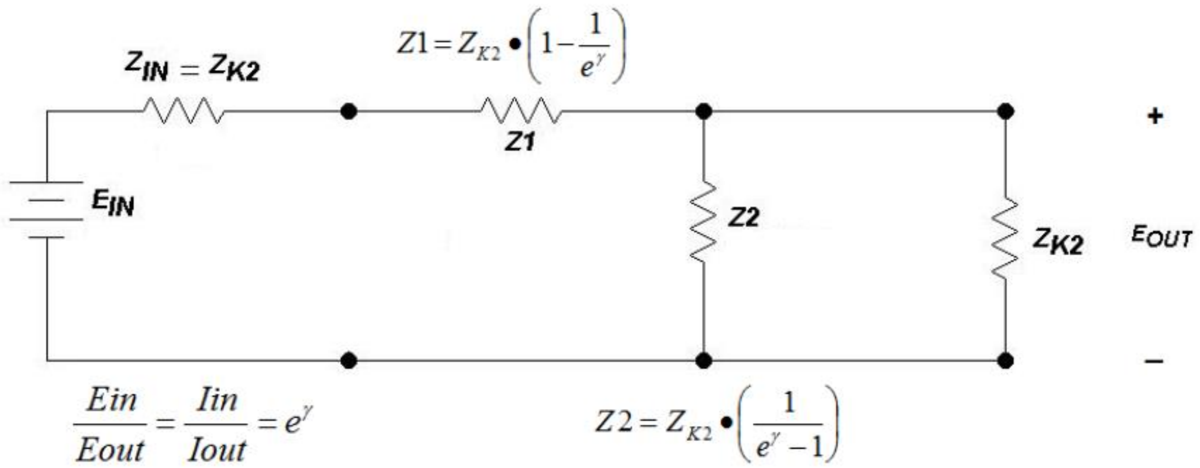
Impedancia de carga y de generador = Zk2 / Z1 y Z2 resistivas puras

Función de propagación:

$$\frac{Ein}{Eout} = \frac{Iin}{Iout} = e^{\gamma}$$

$$Z1 = Z_{K2} \bullet \left(1 - \frac{1}{e^{\gamma}}\right)$$

$$Z2 = Z_{K2} \bullet \left(\frac{1}{e^{\gamma} - 1}\right)$$



IDENTIDADES ALGEBRAICAS DE UTILIDAD

$$senhX = \frac{e^X - e^{-X}}{2}$$

$$\cosh X = \frac{e^X + e^{-X}}{2}$$

$$tgX = \frac{senhX}{\cosh X} = \frac{e^X - e^{-X}}{e^X + e^{-X}}$$

$$\cosh^2 X + senh^2 X = 1$$

$$e^X = \cosh X + senhX$$

$$e^{2X} = \frac{1 + tgX}{1 - tgX}$$

$$senh\frac{X}{2} = \pm\sqrt{\frac{\cosh X - 1}{2}}$$

$$\cosh\frac{X}{2} = \pm\sqrt{\frac{\cosh X + 1}{2}}$$

$$tgh\frac{X}{2} = \frac{\cosh X - 1}{senhX}$$

$$Si \Rightarrow \cosh X = U \qquad senhX = \sqrt{U^2 - 1}$$

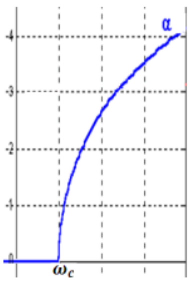
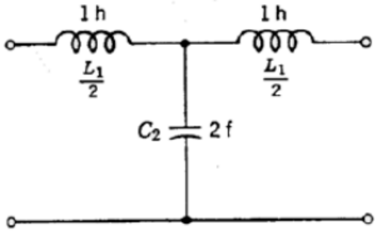
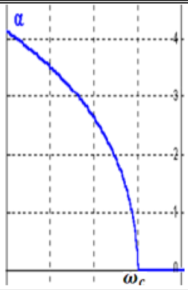
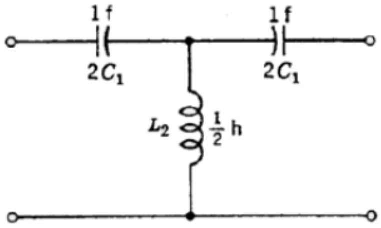
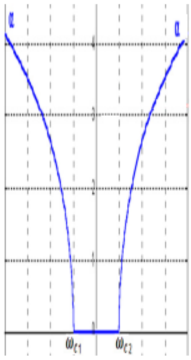
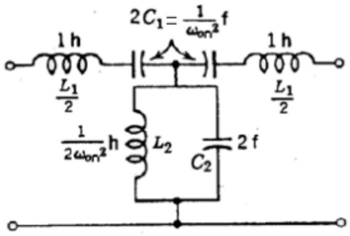
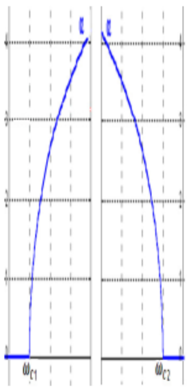
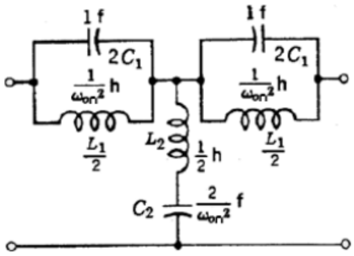
$$Si \Rightarrow senhX = U \qquad \cosh X = \sqrt{U^2 + 1}$$

$$y = \ln\left(x + \sqrt{1 + x^2}\right) \Longleftrightarrow y = \arg\sinh x$$

$$y = \ln\left(x + \sqrt{x^2 - 1}\right) \Longleftrightarrow y = \arg\cosh x$$

$$y = \frac{1}{2}\ln\left(\frac{1 + x}{1 - x}\right) \Longleftrightarrow y = \arg\tanh x$$

FILTROS K-CTE

	CURVA DE ATENUACIÓN	CIRCUITO APLICADO CON VALORES NORMALIZADOS	CÁLCULO DE LOS ELEMENTOS COMPONENTES DEL FILTROS
PASA BAJOS KCTE			$L_1 = \frac{2R_O}{\omega_c} \quad \therefore \quad \frac{L_1}{2} = \frac{R_O}{\omega_c}$ $C_1 = \frac{2}{R_O\omega_c}$ $\omega_c = \frac{2}{\sqrt{L_1 \times C_2}}$ $\lvert X_K \rvert_{pb} = {}^{\omega}/_{\omega_c}$
PASA ALTOS KCTE			$C_1 = \frac{1}{2R_O\omega_c} \quad \therefore \quad 2\ C_1 = \frac{1}{R_O\omega_c}$ $L_2 = \frac{R_O}{2\omega_c}$ $\omega_c = \frac{1}{2\ \sqrt{L_2 \times C_1}}$ $\lvert X_K \rvert_{pa} = -{}^{\omega_c}/_{\omega} = -{}^{1}/_{\lvert X_K \rvert_{pb}}$
PASA-BANDA KCTE			$L_1 = \frac{2R_O}{W} \quad \therefore \quad \frac{L_1}{2} = \frac{R_O}{W}$ $C_1 = \frac{W}{2R_O\omega_O^2} \therefore 2\ C_1 = \frac{W}{R_O\omega_O^2}$ $L_2 = \frac{R_O W}{2\omega_O^2}$ $C_2 = \frac{2}{R_O W}$ $\omega_O = \frac{1}{\sqrt{L_1 \times C_1}} = \frac{1}{\sqrt{L_2 \times C_2}}$ $W = \frac{2R_O}{L_1} = \frac{2}{\sqrt{L_1 \times C_2}}$ $\lvert X_K \rvert_{PB} = \frac{1}{W} X \frac{\omega^2 - \omega_O^2}{\omega}$
ELIMINA-BANDA KCTE			$L_1 = \frac{2R_O W}{\omega_o^2} \quad \therefore \quad \frac{L_1}{2} = \frac{R_O W}{\omega_o^2}$ $C_1 = \frac{1}{2R_o W} \therefore 2\ C_1 = \frac{1}{R_o W}$ $L_2 = \frac{R_O}{2W}$ $C_2 = \frac{2W}{R_O\omega_O^2}$ $\omega_o = \frac{1}{\sqrt{L_1 \times C_1}} = \frac{1}{\sqrt{L_2 \times C_2}}$ $W = \frac{1}{2R_O C_1} = \frac{1}{2\sqrt{L_2 \times C_1}}$ $\lvert X_K \rvert_{PB} = -W \times \frac{\omega}{\omega^2 - \omega_o^2} = -{}^{1}/_{\lvert X_K \rvert_{PB}}$

R_o = Impedancia de carga; ω_C = Pulsación de corte (pb y pa); ω_1 = Pulsación de corte inferior; ω_2 = Pulsación de corte superior; W = Ancho de banda = ω_2-ω_1 y ω_o = Pulsación de Resonancia.

$$AB = W = \omega_{c2} - \omega_{c1} \qquad\qquad \omega_0 = \sqrt{\omega_{c2} . \omega_{c1}}$$