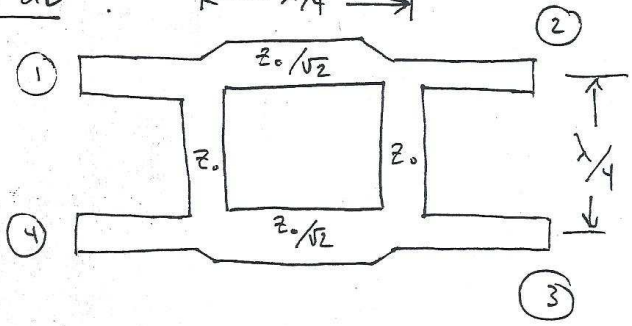
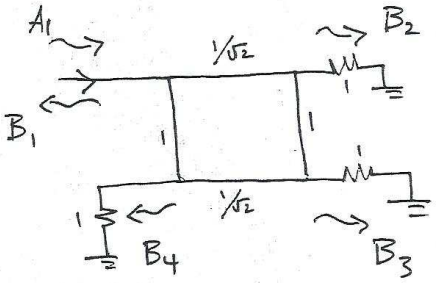
"Branch line Coupler"

- 4 puertos
- simétrica → "even - odd mode"
- ancho de banda estrecho.
- acoplamiento "fuerte" (1 ~ 7 dB)

Diseño 3 dB : ← λ/4 →



Circuito normalizado :



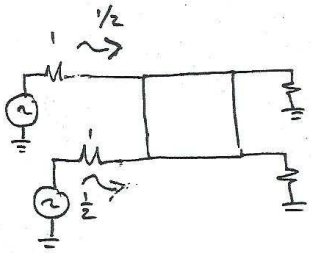
$$S_{11} = \frac{B_1}{A_1}$$

$$S_{21} = \frac{B_2}{A_1}$$

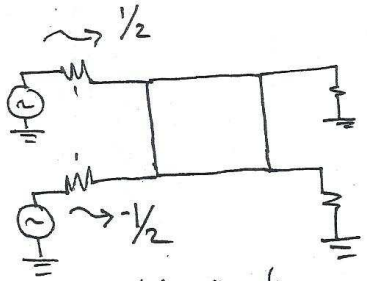
$$S_{31} = \frac{B_3}{A_1}$$

$$S_{41} = \frac{B_4}{A_1}$$

Make $A_1 = 1$

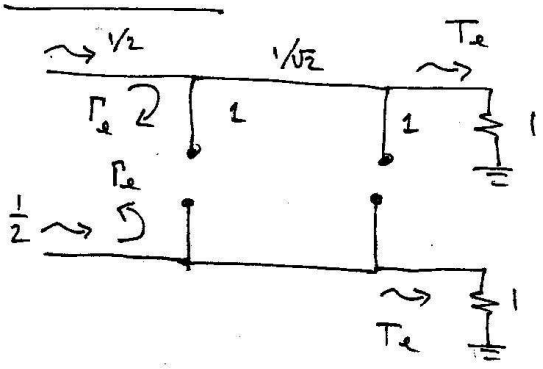


Even - Mode

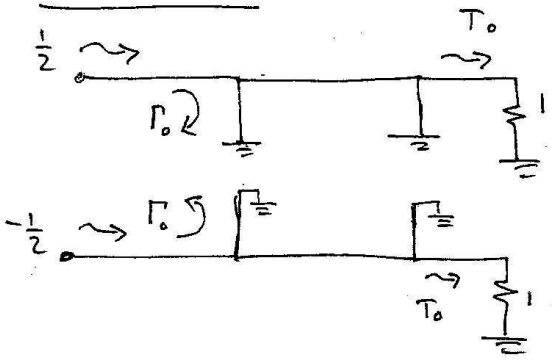


Odd - Mode

Even Mode



Odd Mode



$$\frac{B_1}{A_1} = \frac{B_1}{1} = \frac{1}{2}\Gamma_e + \frac{1}{2}\Gamma_o$$

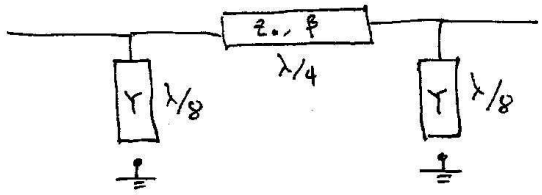
$$B_2 = \frac{1}{2}T_e + \frac{1}{2}T_o$$

$$B_3 = \frac{1}{2}T_e - \frac{1}{2}T_o$$

$$B_4 = \frac{1}{2}\Gamma_e - \frac{1}{2}\Gamma_o$$

— Superposición respuesta modo par + modo impar.

Usando matriz ABCD podemos determinar Γ_e, T_e y Γ_o, T_o



donde

$$z_{o\,\frac{\lambda}{4}} = \frac{1}{\sqrt{2}}$$

$$Y = 1$$

$$\begin{bmatrix} 1 & 0 \\ Y & 1 \end{bmatrix} \cdot \begin{bmatrix} \cos\beta\ell & jz_o \sin\beta\ell \\ jY_o \sin\beta\ell & \cos\beta\ell \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ Y & 1 \end{bmatrix}$$

ABCD "stub" — ABCD línea

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix}_{even} = \begin{bmatrix} 1 & 0 \\ j & 1 \end{bmatrix} \begin{bmatrix} 0 & j/\sqrt{2} \\ j\sqrt{2} & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ j & 1 \end{bmatrix}$$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix}_e = \frac{1}{\sqrt{2}} \begin{bmatrix} -1 & j \\ j & -1 \end{bmatrix}$$

De la misma forma

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix}_{odd} = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & j \\ j & 1 \end{bmatrix}$$

Transformo $[ABCD]_{even} \Rightarrow [S]_{even}$

$[ABCD]_{odd} \Rightarrow [S]_{odd}$

donde

$$[S]_{even} = \begin{bmatrix} \Gamma_e & T_e \\ T_e & \Gamma_e \end{bmatrix}$$

$$[S]_{odd} = \begin{bmatrix} \Gamma_o & T_o \\ T_o & \Gamma_o \end{bmatrix}$$

De tabla <u>5-2</u>

$$\Gamma_e = 0, \quad \Gamma_o = 0, \quad T_e = \frac{-(1+j)}{\sqrt{2}}, \quad T_o = \frac{(1-j)}{\sqrt{2}}$$

De aquí; $B_1 = 0, \quad B_2 = \frac{-j}{\sqrt{2}}, \quad B_3 = -\frac{1}{\sqrt{2}}, \quad B_4 = 0$

$$[S] = \frac{-1}{\sqrt{2}} \begin{bmatrix} 0 & j & 1 & 0 \\ j & 0 & 0 & 1 \\ 1 & 0 & 0 & j \\ 0 & 1 & j & 0 \end{bmatrix}$$

Matriz [S] para híbrido de cuadratura
("Branch line coupler")

3 dB Branch line Coupler

$f_c = 3$ GHz

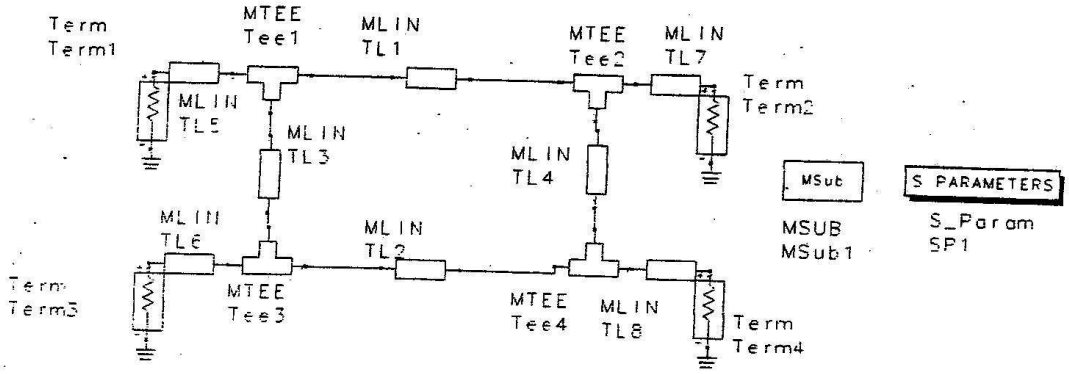
$\epsilon_r = 2.33$ $\quad h = 4$ mils

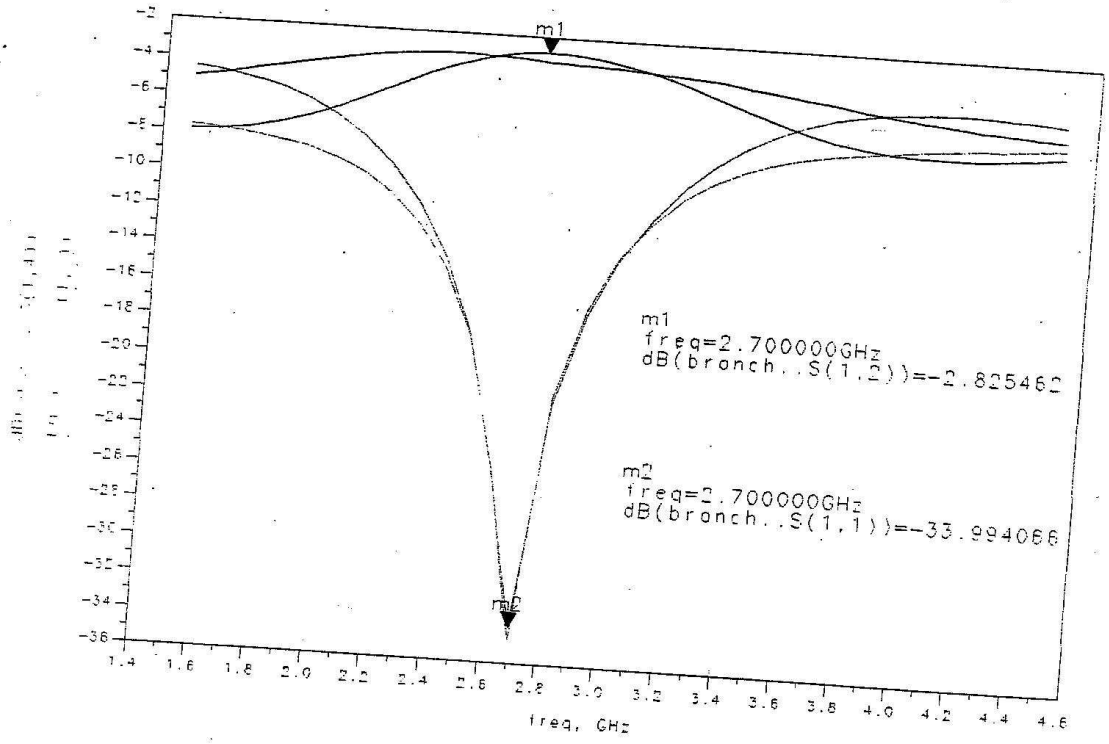
line calc:

$l_{\lambda/4} = 700$ mils

$W_{50\Omega} = 133$ mils

$W_{35.35} = 218$ mils




m1
m2
m1
freq=2.700000GHz
dB(branch..S(1,2))=-2.825462
m2
freq=2.700000GHz
dB(branch..S(1,1))=-33.994066
freq, GHz