

Family name

Given name

Reg. no.

## Exam Exemple

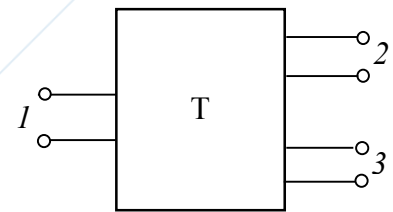
### Problem n. 1

Design a “T” power divider using ideal transmission lines with a characteristic impedance equal to  $Z_{\infty 2}$  and  $Z_{\infty 3}$  and with a length equal to  $\ell = \lambda_{g0}/4$  at the frequency  $f_0 = 3$  GHz. The specs are:

- matched port 1;
- output power ratio of  $P_2/P_3 = \alpha$  with  $\alpha = 0.4$ .

Consider the following reference impedances for the three ports:

$$Z_{r1} = Z_{r2} = Z_{r3} = 50 \Omega.$$



Draw the layout of the microstrip circuit (including the access line) using a dielectric material with  $\epsilon_r = 4$  and  $h = 1.55$  mm.

Compute  $|S_{11}|$  at the frequency  $f = 1.5$  GHz.

Useful formulas for the design of the layout:

$$\frac{W}{d} = \begin{cases} \frac{8e^A}{e^{2A} - 2} & W/d < 2 \\ \frac{2}{\pi} \left[ B - 1 - \ln(2B - 1) + \frac{\epsilon_r - 1}{2\epsilon_r} \left( \ln(B - 1) + 0.39 - \frac{0.61}{\epsilon_r} \right) \right] & W/d > 2 \end{cases}$$

$$A = \frac{Z_0}{60} \sqrt{\frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{\epsilon_r + 1} \left( 0.23 + \frac{0.11}{\epsilon_r} \right)}$$

$$B = \frac{377\pi}{2Z_0\sqrt{\epsilon_r}}$$

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

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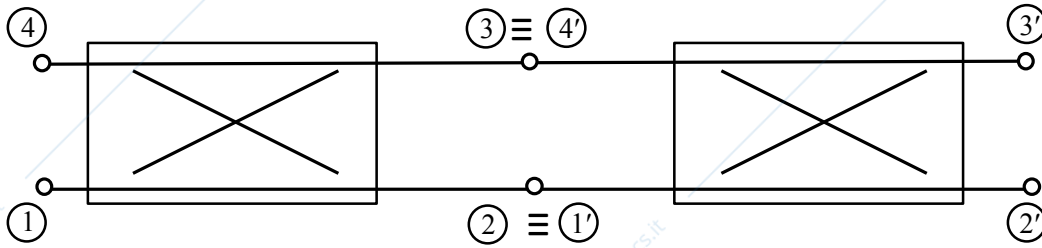
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**Problem n. 2**

Two equal symmetrical directional couplers characterized by  $C = 8$  dB are connected as shown in the picture; they are characterized by the scattering matrices  $[S]$ , defined with respect to the reference impedance  $Z_0$ .

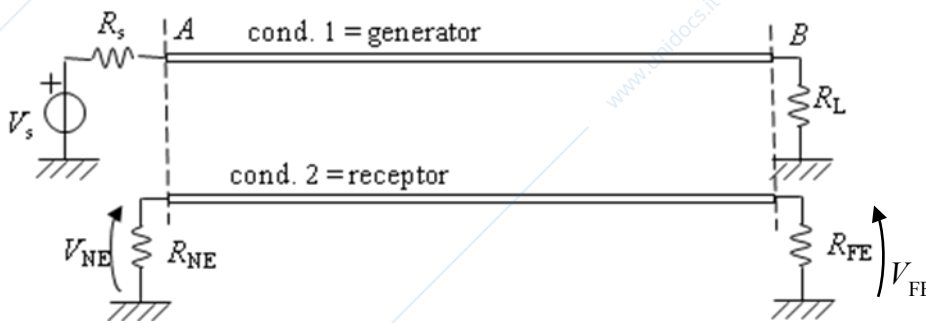
Compute the magnitude and the relative phase of the voltages at the ports 2' and 3' in nominal conditions with respect to the voltage at port 1.



**Problem n. 3**

Consider two close microstrip lines, both with length  $\ell = 3$  cm. Assume the p.u.l. mutual inductance and the p.u.l. mutual capacitance between them to be  $\ell_m = 3.75$  nH/cm and  $c_m = 1.5$  pF/cm.  $V_s(t)$  is a 60 MHz, 0.5 V, 50% duty-cycle trapezoidal pulse train having a rise and fall time equal to 1.2 ns. Suppose that the termination impedances are:  $R_s = R_{NE} = R_L = R$ ,  $R_{FE} = R_1$ .

- Determine the value of  $R$  and  $R_1$  for which the far end voltage is zero and  $|M_{FE}^{ind}| = 2|M_{NE}^{ind}|$ ;
- with the computed value for  $R$  and  $R_1$ , determine the near-end inductive and capacitive coupling coefficients;
- compute the maximum near-end crosstalk voltage.



Receptor equivalent model:

