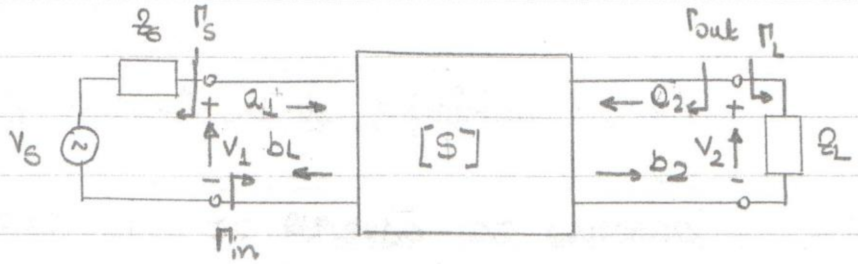
A

$$\widetilde{ROE} = \frac{V_{max}}{V_{min}} = \frac{1+|\Gamma_0|}{1-|\Gamma_0|}$$

DEFINIÇÕES DE GANHOS DE POTÊNCIA DE REDE DE 2 PORTAS



1. GANHO DE POTÊNCIA, G

$$G = \frac{P_L}{P_{in}} \quad (1)$$

P_L: potência dissipada na carga, Z_L

P_{in}: potência entregue à entrada da rede

(1) não depende de Z_S

2. GANHO DE POTÊNCIA DISPONÍVEL

$$G_A = \frac{P_{AVN}}{P_{AVS}} \quad (2)$$

P_{AVN}: potência disponível da rede

P_{AVS}: potência disponível da fonte

casamento conjugado de Z_S e Z_L. Depende de Z_S, mas não de Z_L

3. GANHO DE POTÊNCIA TRANSDUTIVO

$$G_T = \frac{P_L}{P_{AVS}} \quad (3)$$

Depende de Z_S e Z_L

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} \qquad (4)$$

$$\Gamma_S = \frac{Z_S - Z_0}{Z_S + Z_0} \qquad (5)$$

Z_0: impedância de referência

COEFICIENTE DE REFLEXÃO DE ENTRADA

na carga, $\Gamma_L = \frac{a_2}{b_2}$ e $a_2 = \Gamma_L b_2$

$$b_1 = S_{11} a_1 + S_{12} a_2 = S_{11} a_1 + S_{12} \Gamma_L b_2 \qquad (6.1)$$

$$b_2 = S_{21} a_1 + S_{22} a_2 = S_{21} a_1 + S_{22} \Gamma_L b_2 \qquad (6.2)$$

$$\xrightarrow{(6.1)} \quad \frac{b_1}{a_1} = S_{11} + S_{12} \Gamma_L \frac{b_2}{a_1} \qquad (7)$$

$$\xrightarrow{(6.2)} \quad \frac{b_2}{a_1} = S_{21} + S_{22} \Gamma_L \frac{b_2}{a_1} \qquad (8)$$

$$\xrightarrow{(8)} \quad \frac{b_2}{a_1}(1 - S_{22}\Gamma_L) = S_{21} \quad e \quad \frac{b_2}{a_1} = \frac{S_{21}}{1 - S_{22}\Gamma_L} \qquad (9)$$

(9) em (7),

$$\frac{b_1}{a_1} = S_{11} + \frac{S_{12} S_{21} \Gamma_L}{1 - S_{22}\Gamma_L} = \Gamma_{in} \qquad (10)$$

Analogamente,

$$\Gamma_{out} = \frac{b_2}{a_2} = S_{22} + \frac{S_{12} S_{21} \Gamma_S}{1 - S_{11}\Gamma_S} \qquad (11)$$

A tensão V_1 na entrada da rede é

$$V_1 = V_S \frac{Z_{in}}{Z_{in} + Z_S} \qquad (12)$$

$$V_1 = a_1 + b_1 \; ; \quad \Gamma_{in} = \frac{b_1}{a_1} \quad e \quad b_1 = \Gamma_{in} a_1$$

$$V_1 = a_1 + \Gamma_{in} a_1 = a_1 (1 + \Gamma_{in})$$

$$\therefore \; V_S \frac{Z_{in}}{Z_{in} + Z_S} = a_1 (1 + \Gamma_{in}) \qquad (13)$$

Mas,

$$Z_{in} = Z_0 \cdot \frac{1 + \Gamma_{in}}{1 - \Gamma_{in}} \; ; \quad Z_S = Z_0 \cdot \frac{1 + \Gamma_S}{1 - \Gamma_S} \qquad (14)$$

(14) em (13)

$$a_1 = V_S \cdot \frac{Z_{in}}{Z_{in} + Z_S} \cdot \frac{1}{(1 + \Gamma_{in})} \qquad (15)$$

$$\frac{Z_{in}}{Z_{in} + Z_S} = \frac{Z_0 (1 + \Gamma_{in})}{(1 - \Gamma_{in})} \cdot \frac{1}{\frac{Z_0 (1 + \Gamma_{in})}{1 - \Gamma_{in}} + \frac{Z_0 (1 + \Gamma_S)}{1 - \Gamma_S}}$$

$$= \frac{Z_0 (1 + \Gamma_{in})}{Z_0 (1 + \Gamma_{in}) + \frac{Z_0 (1 - \Gamma_{in})(1 + \Gamma_S)}{1 - \Gamma_S}}$$

$$= \frac{Z_0 (1 + \Gamma_{in})(1 - \Gamma_S)}{Z_0 (1 + \Gamma_{in})(1 - \Gamma_S) + Z_0 (1 - \Gamma_{in})(1 + \Gamma_S)} \qquad (16)$$

$$(1 + \Gamma_{in})(1 - \Gamma_S) + (1 - \Gamma_{in})(1 + \Gamma_S) = 1 \cancel{- \Gamma_S} \cancel{+ \Gamma_{in}} - \Gamma_{in}\Gamma_S + 1 \cancel{+ \Gamma_S} \cancel{- \Gamma_{in}} - \Gamma_{in}\Gamma_S$$

$$= 2 - 2\Gamma_{in}\Gamma_S = 2(1 - \Gamma_{in}\Gamma_S) \qquad (17)$$

(17) em (16)

$$= \frac{(1 + \Gamma_{in})(1 - \Gamma_S)}{2(1 - \Gamma_{in}\Gamma_S)} \qquad (18)$$

(18) em (15)

$$\tilde{a}_1 = \frac{\tilde{V}_S}{2} \cdot \frac{(1 - \Gamma_S)}{1 - \Gamma_{in}\Gamma_S} \qquad (19)$$

Potência média entregue à rede:

$$P_{in} = \frac{1}{2Z_0}|V_1^+|^2 - \frac{1}{2Z_0}|\Gamma_{in}|^2 |V_1^+|^2 = \frac{1}{2Z_0}|V_1^+|^2(1-|\Gamma_{in}|^2) \quad (20)$$

(19) em (20):

$$P_{in} = \frac{1}{2Z_0}(1-|\Gamma_{in}|^2) \cdot \frac{|V_S|^2}{4} \frac{|1-\Gamma_S|^2}{|1-\Gamma_S\Gamma_{in}|^2}$$

ou

$$P_{in} = \frac{|V_S|^2}{8Z_0} \frac{|1-\Gamma_S|^2}{|1-\Gamma_S\Gamma_{in}|^2}(1-|\Gamma_{in}|^2) \quad (21)$$

Potência entregue à carga

$$P_L = \frac{|V_2^-|^2}{2Z_0}(1-|\Gamma_L|^2) \quad (22)$$

$$\xrightarrow{(6.2)} V_2^-(1-S_{22}\Gamma_L) = S_{21}V_1^+ \quad \text{ou} \quad V_2^- = \frac{S_{21}}{1-S_{22}\Gamma_L}V_1^+ \quad (23)$$

(19) em (23),

$$V_2^- = \frac{S_{21}}{1-S_{22}\Gamma_L} \cdot \frac{V_S}{2} \frac{(1-\Gamma_S)}{(1-\Gamma_S\Gamma_L)} \quad (24)$$

(24) em (22),

$$P_L = \frac{|V_S|^2}{8Z_0} \cdot \frac{|S_{21}|^2 |1-\Gamma_S|^2 (1-|\Gamma_L|^2)}{|1-S_{22}\Gamma_L|^2 |1-\Gamma_S\Gamma_{in}|^2} \quad (25)$$

$$\therefore \quad G = \frac{P_L}{P_{in}} = \frac{|S_{21}|^2(1-|\Gamma_L|^2)}{(1-|\Gamma_{in}|^2)|1-S_{22}\Gamma_L|^2} \quad (26)$$

Potência disponível da fonte
máxima potência que pode ser entregue à rede:
condição: casamento conjugado: $\Gamma_{in} = \Gamma_S^*$

$$P_{AVS} = P_{in}\Big|_{\Gamma_{in}=\Gamma_S^*} = \frac{|V_S|^2}{8 Z_0} \cdot \frac{|1-\Gamma_S|^2}{|1-\Gamma_S\Gamma_S^*|^2} (1-|\Gamma_S^*|^2)$$

mas, $\Gamma_S\Gamma_S^* = |\Gamma_S|^2$ e $|1-\Gamma_S\Gamma_S^*|^2 = |1-|\Gamma_S|^2|^2 = (1-|\Gamma_S|^2)^2$
e $|\Gamma_S^*|^2 = |\Gamma_S|^2$

$$\therefore\ P_{AVS} = \frac{|V_S|^2}{8 Z_0} \cdot \frac{|1-\Gamma_S|^2}{(1-|\Gamma_S|^2)} \qquad (27)$$

Potência disponível da rede
máxima potência que pode ser entregue à carga

$$P_{AVN} = P_L\Big|_{\Gamma_{out}=\Gamma_L^*}$$

$$P_L\Big|_{\Gamma_{out}=\Gamma_L^*} = \frac{|V_S|^2}{8 Z_0} \left. \frac{|S_{21}|^2 (1-|\Gamma_{out}^*|^2)|1-\Gamma_S|^2}{|1-S_{22}\Gamma_{out}^*|^2 |1-\Gamma_S\Gamma_{in}|^2}\right|_{\Gamma_{out}=\Gamma_L^*} \qquad (28)$$

Mas, $|\Gamma_{out}^*| = |\Gamma_{out}|$
e $\Gamma_{in} = S_{11} + \dfrac{S_{12}S_{21}\Gamma_L}{1-S_{22}\Gamma_L}$; $\Gamma_{out} = S_{22} + \dfrac{S_{12}S_{21}\Gamma_S}{1-S_{11}\Gamma_S}$

Temos que

$$\Gamma_{out}(1-S_{11}\Gamma_S) = S_{22}(1-S_{11}\Gamma_S) + S_{12}S_{21}\Gamma_S$$

$$S_{12}S_{21}\Gamma_S = \Gamma_{out}(1-S_{11}\Gamma_S) - S_{22}(1-S_{11}\Gamma_S)$$

$$S_{12}S_{21}\Gamma_S = (1-S_{11}\Gamma_S)(\Gamma_{out}-S_{22})$$

Substituindo na expressão de $\Gamma_{in}\Gamma_S$

$$\Gamma_S\Gamma_{in} = S_{11}\Gamma_S + \frac{(1-S_{11}\Gamma_S)(\Gamma_{out}-S_{22})\Gamma_L}{1-S_{22}\Gamma_L}$$

para $\Gamma_L = \Gamma_{out}^*$

$$\Gamma_S \Gamma_{in} = S_{11}\Gamma_S + \frac{(1-S_{11}\Gamma_S)(\Gamma_{out}-S_{22})\Gamma_{out}^*}{1-S_{22}\Gamma_{out}^*}$$

$$1-\Gamma_S\Gamma_{in} = (1-S_{11}\Gamma_S) - \frac{(1-S_{11}\Gamma_S)(\Gamma_{out}\Gamma_{out}^* - S_{22}\Gamma_{out}^*)}{1-S_{22}\Gamma_{out}^*}$$

$$1-\Gamma_S\Gamma_{in} = (1-S_{11}\Gamma_S)\left[1 - \frac{(|\Gamma_{out}|^2 - S_{22}\Gamma_{out}^*)}{1-S_{22}\Gamma_{out}^*}\right]$$

$$1-\Gamma_S\Gamma_{in} = (1-S_{11}\Gamma_S)\left[\frac{1-S_{22}\Gamma_{out}^* - |\Gamma_{out}|^2 + S_{22}\Gamma_{out}^*}{1-S_{22}\Gamma_{out}^*}\right]$$

$$1-\Gamma_S\Gamma_{in} = \frac{(1-S_{11}\Gamma_S)(1-|\Gamma_{out}|^2)}{1-S_{22}\Gamma_{out}^*}$$

e

$$|1-\Gamma_S\Gamma_{in}|^2 = \frac{|1-S_{11}\Gamma_S|^2 (1-|\Gamma_{out}|^2)^2}{|1-S_{22}\Gamma_{out}^*|^2} \qquad (29)$$

Substituindo (29) em (28)

$$P_{AVN} = \frac{|V_S|^2}{8Z_0}|S_{21}|^2 \frac{(1-|\Gamma_{out}^*|^2)|1-\Gamma_S|^2}{|1-S_{22}\Gamma_{out}^*|^2} \cdot \frac{|1-S_{22}\Gamma_{out}^*|^2}{|1-S_{11}\Gamma_S|^2(1-|\Gamma_{out}|^2)^2}$$

e

$$P_{AVN} = \frac{|V_S|^2}{8Z_0}|S_{21}|^2 \frac{|1-\Gamma_S|^2}{|1-S_{11}\Gamma_S|^2(1-|\Gamma_{out}|^2)} \qquad (30)$$

$$G_A = \frac{P_{AVN}}{P_{AVS}} = \frac{|S_{21}|^2(1-|\Gamma_S|^2)}{|1-S_{11}\Gamma_S|^2(1-|\Gamma_{out}|^2)} \qquad (31)$$

De (25) e (27):

$$G_T = \frac{P_L}{P_{AVS}} = \frac{|S_{21}|^2(1-|\Gamma_S|^2)(1-|\Gamma_L|^2)}{|1-\Gamma_S\Gamma_{in}|^2|1-S_{22}\Gamma_L|^2} \qquad (32)$$