Stability of active device

\[ |\Gamma_L| < 1, |\Gamma_S| < 1, |\Gamma_{in}| < 1, |\Gamma_{out}| < 1 \]

\[ k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |S_{11}S_{22} - S_{12}S_{21}|^2}{2|S_{12}||S_{21}|} \]

If not unconditionally stable

BFG505W

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Constant Gain Amplifier

\[ G_{TU} = \frac{1 - |\Gamma_S|^2}{|1 - S_{11}\Gamma_S|^2} \times |S_{21}|^2 \times \frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2} \]

\[ G_{TU}(dB) = G_S(dB) + G_0(dB) + G_L(dB) \]
Constant gain circles in the SC

\[ G_{S\text{max}} = \frac{1}{1 - |S_{11}|^2} \]

\[ g_S = \frac{G_S}{G_{S\text{max}}} = \frac{1 - |\Gamma_S|^2}{|1 - \Gamma_S S_{11}|^2} (1 - |S_{11}|^2) \]

\[ G_{L\text{max}} = \frac{1}{1 - |S_{22}|^2} \]

\[ g_L = \frac{G_L}{G_{L\text{max}}} = \frac{1 - |\Gamma_L|^2}{|1 - \Gamma_L S_{22}|^2} (1 - |S_{22}|^2) \]

\[ g_i = \frac{G_i}{G_{i\text{max}}} = \frac{1 - |\Gamma_i|^2}{|1 - \Gamma_i S_{ii}|^2} (1 - |S_{ii}|^2) \]

This can be written as a circle equation.
Circle equation and graphical display

\[
(\Gamma_i^R - d_{gi}^R)^2 + (\Gamma_i^I - d_{gi}^I)^2 = r_{gi}^2
\]

\[
d_{gi} = \frac{g_i S_{ii}^*}{1 - |S_{ii}|^2 (1 - g_i)}
\]

\[
r_{gi} = \frac{\sqrt{1 - g_i} (1 - |S_{ii}|^2)}{1 - |S_{ii}|^2 (1 - g_i)}
\]

Constant source gain circles

Constant load gain circle

See Ex. 9.7 (p. 507)
Trade-off between gain and noise

Maximum gain and minimum noise figure are mutually exclusive

Noise figure

Constant gain

Input and output VSWR as a function of $\Gamma_s$ position

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