Low-power radio design for the IoT
Exercise 6 (22.04.2021)

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Problem 1 Noise Parameters of Common-Source Stage

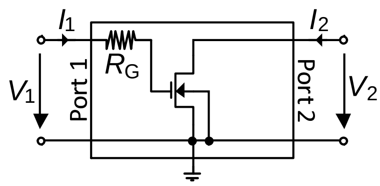

Figure 1: Two-port network corresponding to a common-source amplifier (bias not shown)

Fig. 1 shows the two-port network corresponding to a source-gate stage including the gate resistance, but without the details of the bias network.

1.1 Small-Signal Equivalent Schematic

Draw the small-signal schematic (only account for the gate-to-source capacitance C_{GS}, no other capacitances)

1.2 Two-Port Noise Parameters

Calculate the noise parameters of the noisy two-port accounting for the channel noise (drain noise) and the noise of the gate resistance. Ignore the induced gate noise and the correlation between drain and gate noise (parameter $c_g = 0$)

- First calculate the parameters R_v, G_i, G_c and B_c
- Then derive the noise parameters G_{opt}, B_{opt} and F_{min}

1.3 Effective Noise Factor

Calculate the effective noise factor by the following two different equivalent methods.

- Use the expressions for the noise parameters R_v, G_i, G_c and B_c
- Directly by calculating the total input referred noise voltage (v_{neq})

1.4 F versus IC

Sketch the noise factor F as a function of the inversion coefficient IC in the following conditions:

- Assume long-channel transistor. Hint: γ_{nD} constant.
- Assume short-channel transistor. Hint: $\gamma_{\mathrm{nD}} = 1 + \alpha \cdot IC$.
- Comment on the differences between the two plots and the optimum design for noise in both cases.