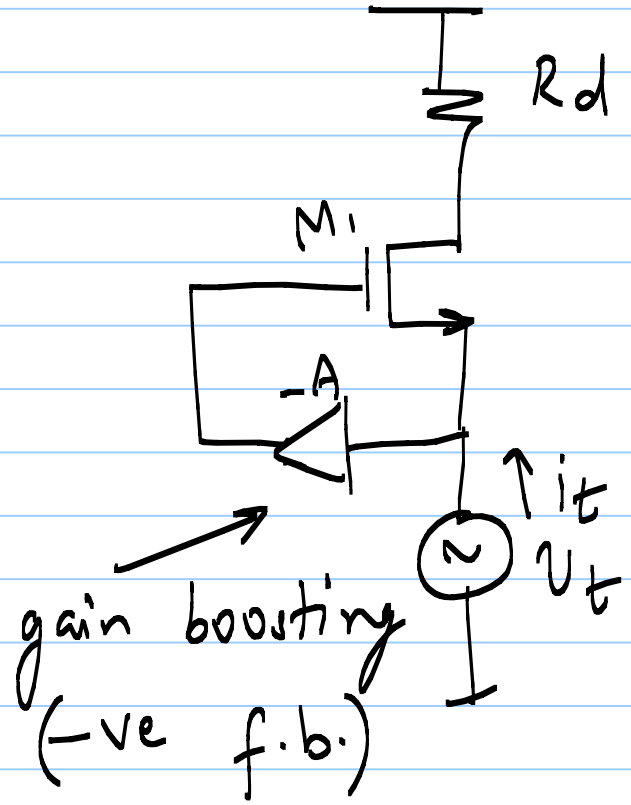
12/3/20

Lec 23

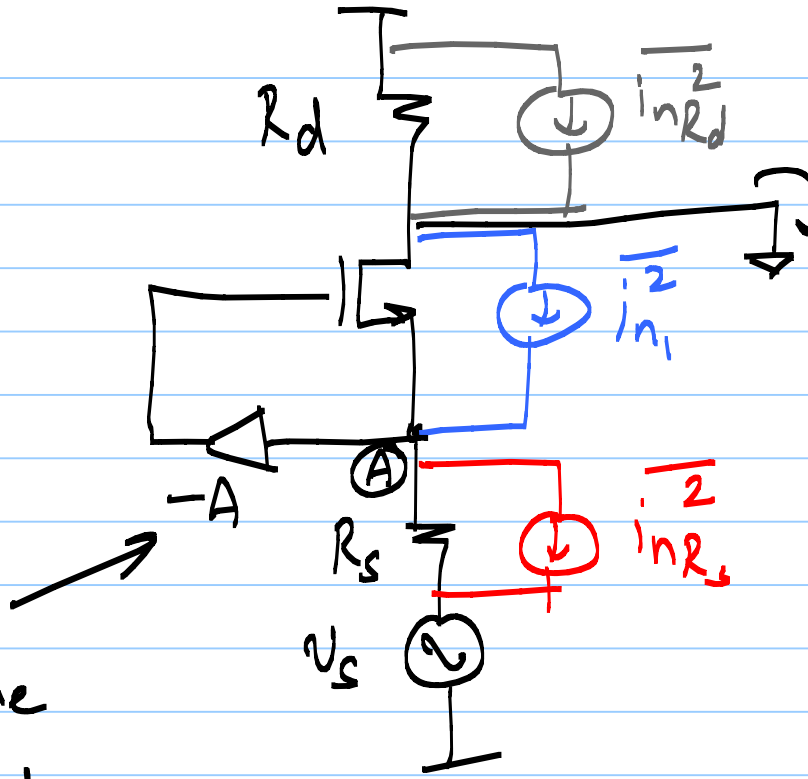


$$Z_{in} = \frac{v_t}{i_t} = \frac{1}{g_m(1+A)}$$

we want $Z_{in} = 50\Omega$

for regular CMLNA, $g_m = 20mS$

here choose $g_m = \frac{20mS}{1+A}$



assume noiseless A

$$v_A = \frac{v_s}{2}; \quad g_m = \frac{20mS}{1+A}$$

$$R_{in} = \frac{1}{g_m(1+A)} = 50\Omega$$

$$\overline{i_{scn_{R_s}}^2} = \left|\frac{i_{nR_s}}{2}\right|^2 = kT/R_s$$

$$\overline{i_{scn_{R_d}}^2} = \overline{i_{nR_d}^2} = \frac{4kT}{R_d}$$

$$\overline{i_{scn_{M_1}}^2} = \left|\frac{i_{nM_1}}{2}\right|^2 = kT\gamma g_m$$

$$NF = 1 + \frac{4kT/R_d + kT\gamma g_m}{kT/R_s}$$

$$= 1 + \gamma g_m R_s + \frac{4R_s}{R_d} = 1+$$

Original CG LNA :

$$NF = 1 + \gamma + \frac{4R_s}{R_d}$$

$$g_m = \frac{2g_{ms}}{1+A} = \frac{1}{R_s(1+A)}$$

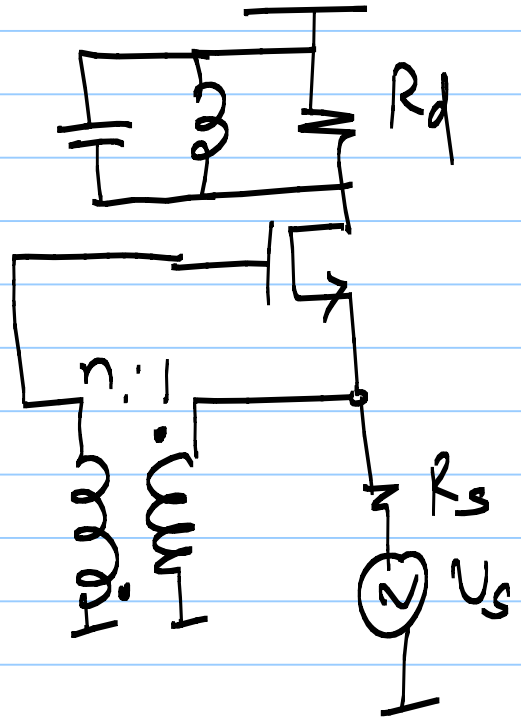
$$g_m R_s = \frac{1}{1+A}$$

$$NF_{\text{gain boosted CG LNA}} = 1 + \frac{\gamma}{1+A} + \frac{4R_s}{R_d}$$

Ampl. A adds noise

* A - CS amplifier
* C_{in} of A affects high freq. S_{11}

* g_m of CSA should be large
  — small device, large current



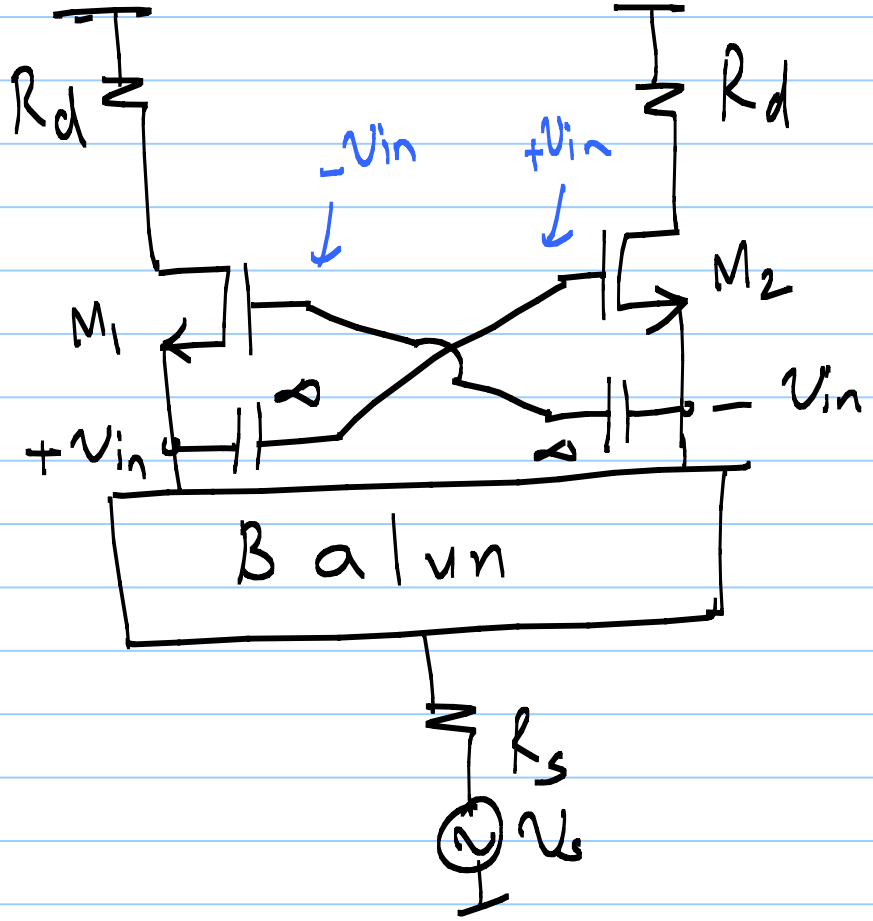
Use a Xfmr

1:1 Xfmr has A=1

$$NF = 1 + \frac{\gamma}{2} + \frac{4R_s}{R_d}$$

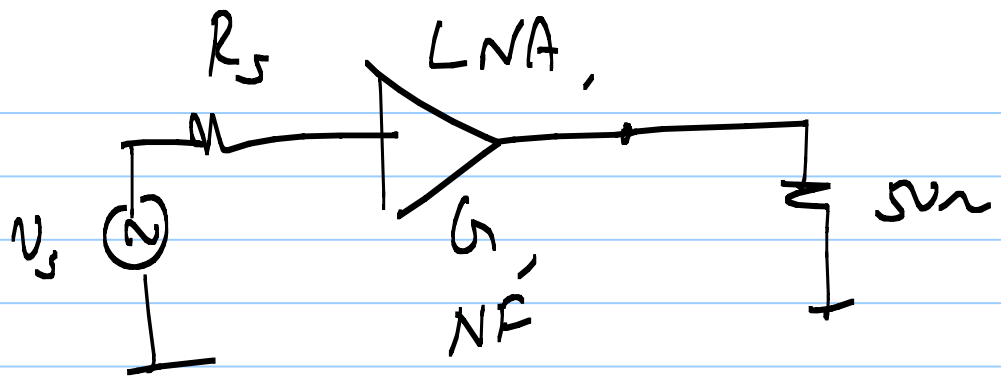
1:n Xfmr can do much better

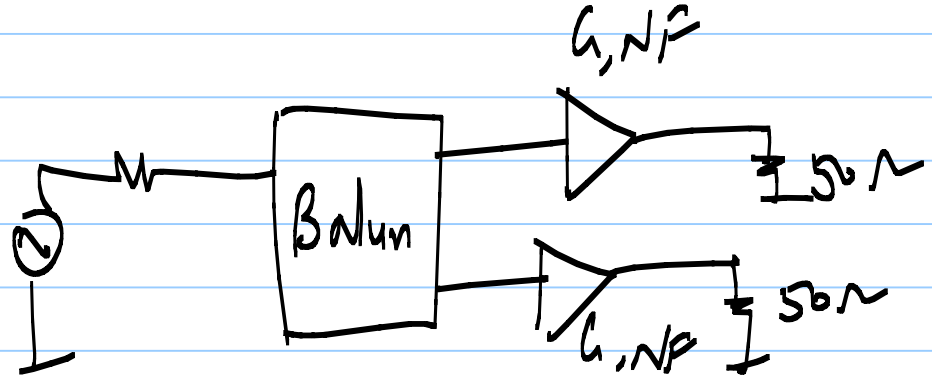
n is limited for IC implementations



* noise from M_1 & M_2 goes down by 1/2

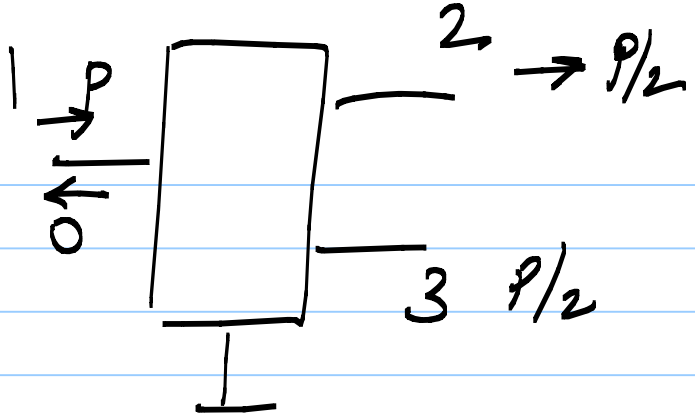
* 'Broadband'
  - balun limits BW



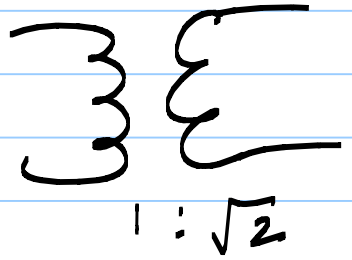


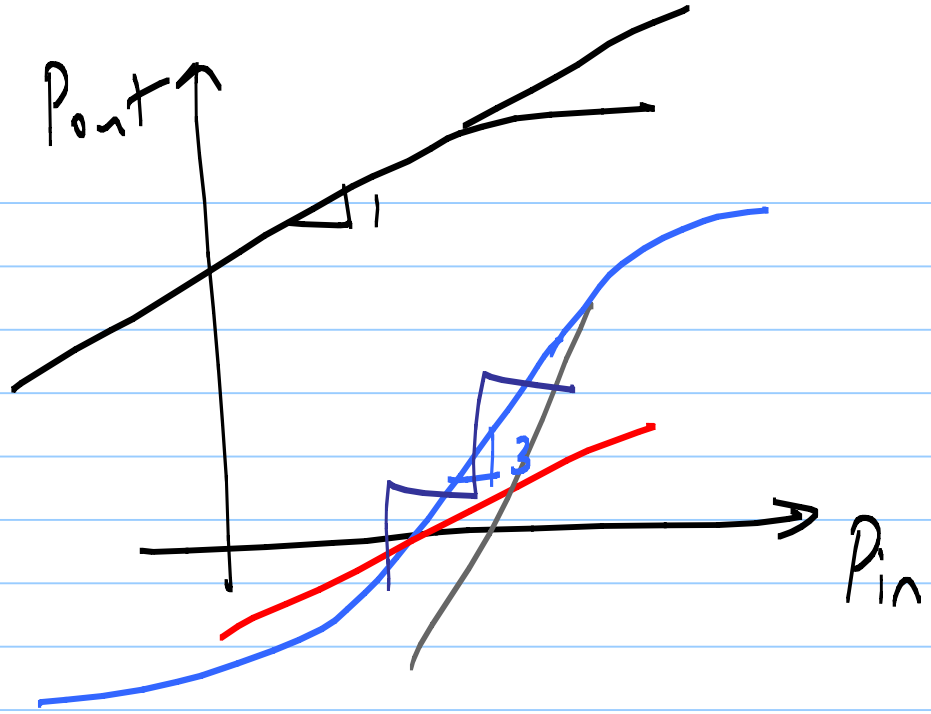
$NF' = ?$

Ideal Balun



$$[S] = \begin{bmatrix} 0 & 1/2 & 1/2 \\ 1/2 & 0 & 0 \\ 1/2 & 0 & 0 \end{bmatrix}_{3 \times 3}$$




P_{out}
1
3
P_{in}