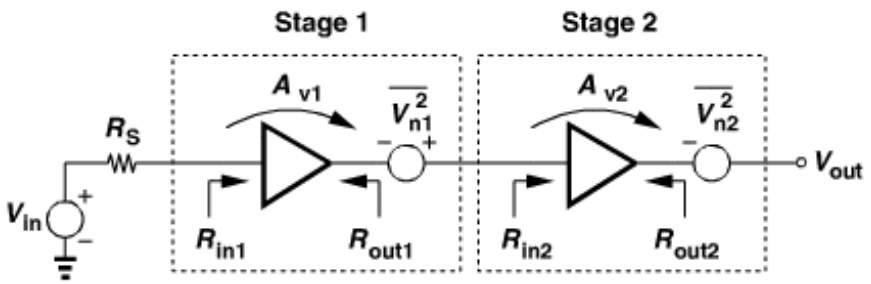
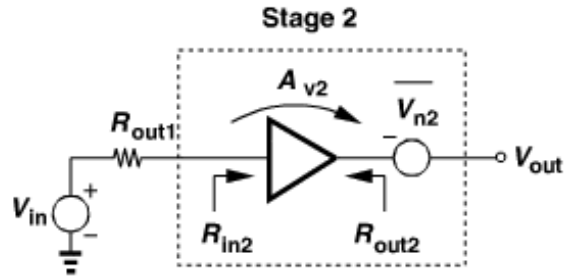


$$A_0 = \frac{V_{out}}{V_{in}} = \frac{R_{in1}}{R_{in1} + R_S} A_{v1} \frac{R_{in2}}{R_{in2} + R_{out1}} A_{v2}$$

$$\overline{V_{n,out}^2} = \overline{V_{n2}^2} + \overline{V_{n1}^2} \frac{R_{in2}^2}{(R_{in2} + R_{out1})^2} A_{v2}^2.$$

$$\begin{aligned} \mathrm{NF_{tot}} &= 1 + \frac{\overline{V_{n,out}^2}}{A_0^2} \cdot \frac{1}{4kTR_S} \\ &= 1 + \frac{\overline{V_{n1}^2}}{\left(\frac{R_{in1}}{R_{in1} + R_S}\right)^2 A_{v1}^2} \cdot \frac{1}{4kTR_S} \\ &\quad + \frac{\overline{V_{n2}^2}}{\left(\frac{R_{in1}}{R_{in1} + R_S}\right)^2 A_{v1}^2 \left(\frac{R_{in2}}{R_{in2} + R_{out1}}\right)^2 A_{v2}^2} \cdot \frac{1}{4kTR_S} \end{aligned}$$

$$NF_{tot} = 1 + (NF_1 - 1) + \frac{NF_2 - 1}{A_{P1}} + \cdots + \frac{NF_m - 1}{A_{P1} \cdots A_{P(m-1)}}.$$



$$NF_2 = 1 + \frac{\overline{V_{n2}^2}}{\frac{R_{in2}^2}{(R_{in2} + R_{out1})^2} A_{v2}^2} \frac{1}{4kTR_{out1}}.$$

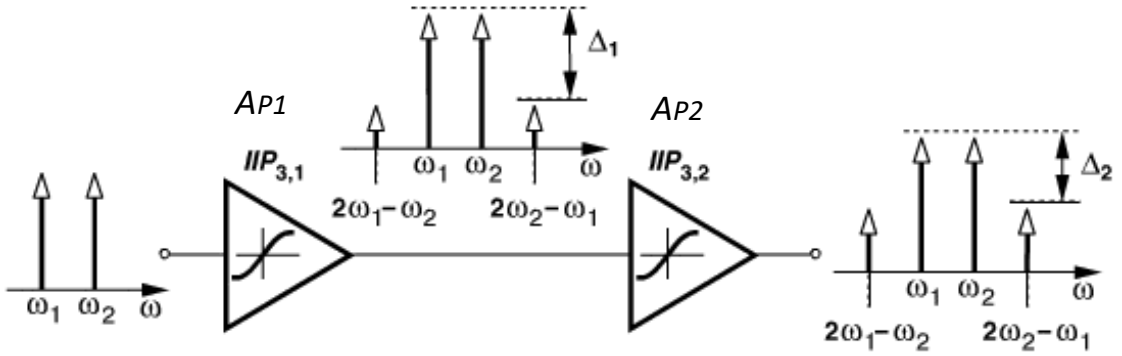
$$NF_{tot} = NF_1 + \frac{NF_2 - 1}{\frac{R_{in1}^2}{(R_{in1} + R_S)^2} A_{v1}^2 \frac{R_S}{R_{out1}}}.$$

$$P_{out,av} = V_{in}^2 \frac{R_{in1}^2}{(R_S + R_{in1})^2} A_{v1}^2 \cdot \frac{1}{4R_{out1}}.$$ Available output power

$$P_{S,av} = \frac{V_{in}^2}{4R_S}.$$ Available source power

$$NF_{tot} = NF_1 + \frac{NF_2 - 1}{A_{P1}}$$, with $A_{P1} = \frac{P_{out,av}}{P_{S,av}}$

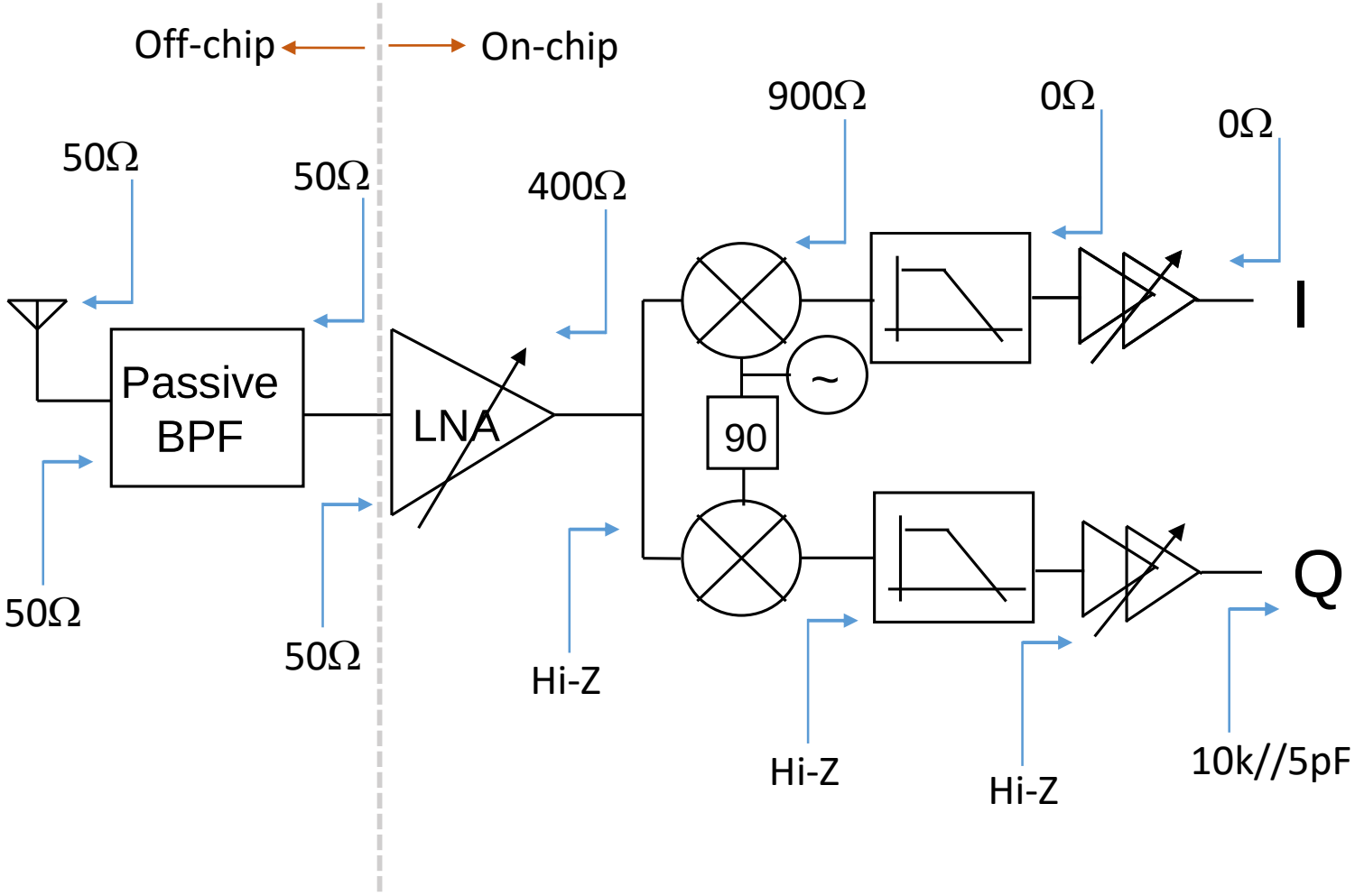
Cascade IIP3 calculation (courtesy of prof. Behzad Razavi)



$$\frac{1}{IIP3_{total}} = \frac{1}{IIP3_1} + \frac{A_{P1}}{IIP3_2} + \frac{A_{P1}A_{P2}}{IIP3_3} + ..$$

IIP3 is in linear power

A_P is available power gain


Off-chip
On-chip
50Ω
50Ω
400Ω
900Ω
0Ω
0Ω
Passive BPF
LNA
~
90
I
Q
50Ω
50Ω
Hi-Z
Hi-Z
Hi-Z
10k//5pF