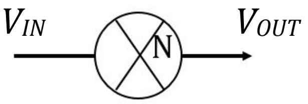
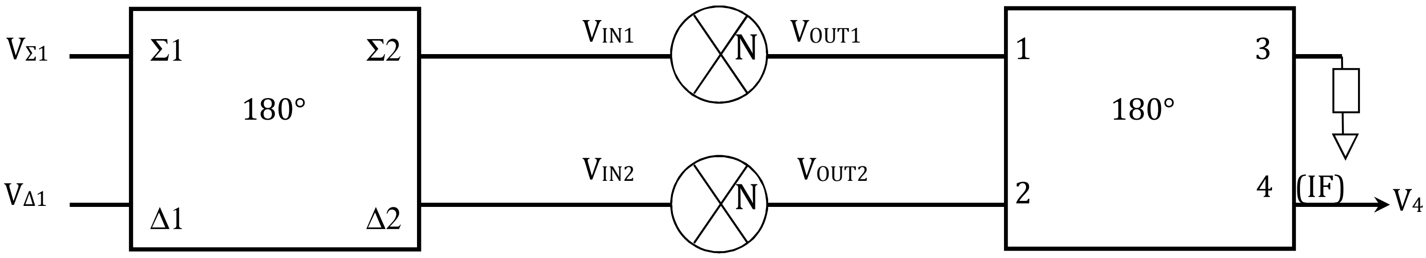
Tutorial (Balanced Mixer SBM)

■The mixer is based on a **nonlinear device N** characterized with the following 3rd order transfer function :



$V_{OUT} = a.V_{IN}^2 - b.V_{IN}^3$ where (a and b) are constants

■The following block diagram represents a **single balanced mixer SBM** consisting of two 180°-couplers and two identical mixers N.



1) In the studied case, the input voltages are $V_{\Sigma 1}=(\sqrt{2}.V_{RF})$ and $V_{\Delta 1}=(\sqrt{2}.V_{LO})$.
Therefore, express the input control voltages V_{IN1} and V_{IN2} of N as a function of V_{LO} and V_{RF}.

2) Deduce the expressions of output voltages (V_{OUT1}, V_{OUT2}) as a function of V_{LO} and V_{RF}.

3) The SBM down-converter is designed at an IF angular frequency $\omega_{IF}=\omega_{LO}-\omega_{RF}$.
What should be the type (Σ or Δ?) of port 4 in the output coupler?

4) Given that $V_{LO}=V_0.\cos(\omega_{LO}.t)$ and $V_{RF}=V_1.\cos(\omega_{RF}.t)$, express the output voltage spectrum V_4 of the SBM as a function of V_0 and V_1. What are the remaining frequencies at the IF output port of the SBM?

5) What are the advantages of this SBM configuration (LO input at Δ port)?

6) Express the voltage conversion gain G_{CV} of the SBM. What is the power conversion gain G_{CP} if all 180° couplers are matched to 50Ω ?

7) What are the values of LO-to-RF and LO-to-IF isolations?