Extraction of Conversion Matrices for PHEMTs based on Vectorial Large-Signal Measurements

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conversion admittance matrix

- the objective of the work is to provide a **behavioural F.D. description** of the nonlinear device suitable for mixer design starting from Large-Signal Vectorial Measurements

$$\begin{vmatrix} i^*_{1,-N} \\ \vdots \\ i_{1,0} \\ \vdots \\ i_{1,N} \\ i^*_{2,-N} \\ \vdots \\ i_{2,0} \\ \vdots \\ i_{2,N} \end{vmatrix} = \left|\begin{array}{ccc|c} y_{1,1,-N,-N} & \cdots & y_{1,1,-N,N} & \vdots \\ \vdots & \ddots & \vdots & \cdots y_{1,2,n,m} \cdots \\ y_{1,1,N,-N} & \cdots & y_{1,1,N,N} & \vdots \\ \hline & \vdots & & \vdots \\ & \cdots y_{2,1,n,m} \cdots & & \cdots y_{2,2,n,m} \cdots \\ & \vdots & & \vdots \end{array}\right| \times \begin{vmatrix} v^*_{1,-N} \\ \vdots \\ v_{1,0} \\ \vdots \\ v_{1,N} \\ v^*_{2,-N} \\ \vdots \\ v_{2,0} \\ \vdots \\ v_{2,N} \end{vmatrix}$$

$$y_{ijmn} = i_{i,m} / v_{j,n}$$

port

IMP index

m,n<0: left side band

m,n>0: right side band

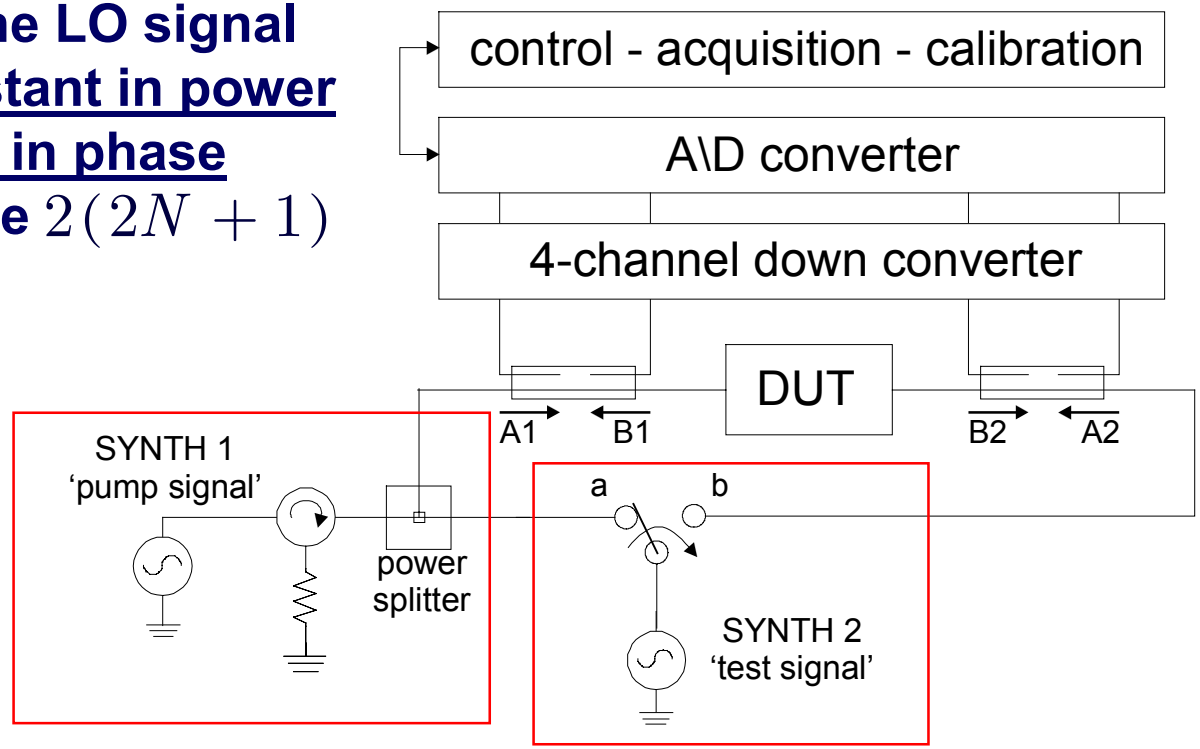
- no. unknowns: $4(2N+1)^2$, represented by 'Yijmn'; no. equations: $2(2N+1)$, represented by the $v - i$ column vectors

it is required a collection of $2(2N+1)$ linearly independent column vectors to solve the system.

measurement set-up

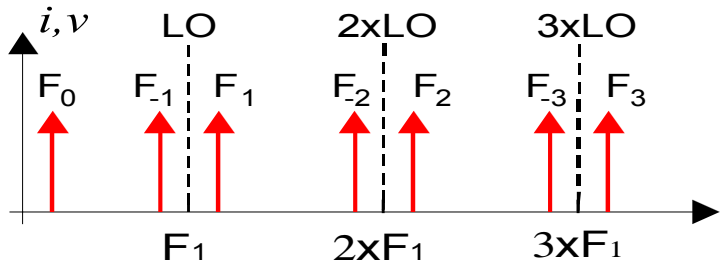
- the modified NVNA set-up permits to apply a small-level test signal along with a pump signal

in principle the LO signal must be <u>constant in power</u> and <u>coherent in phase</u> through all the $2(2N+1)$ experiments



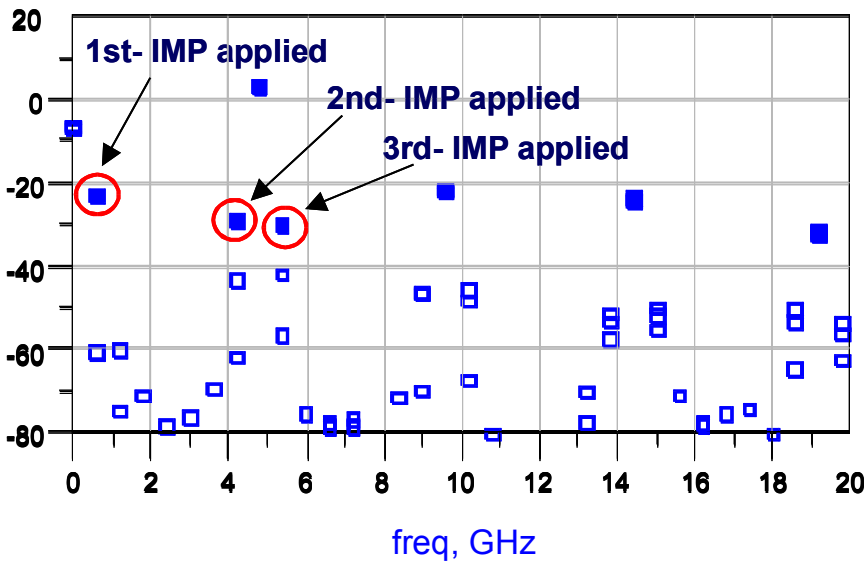
method II

- IMP indexes:

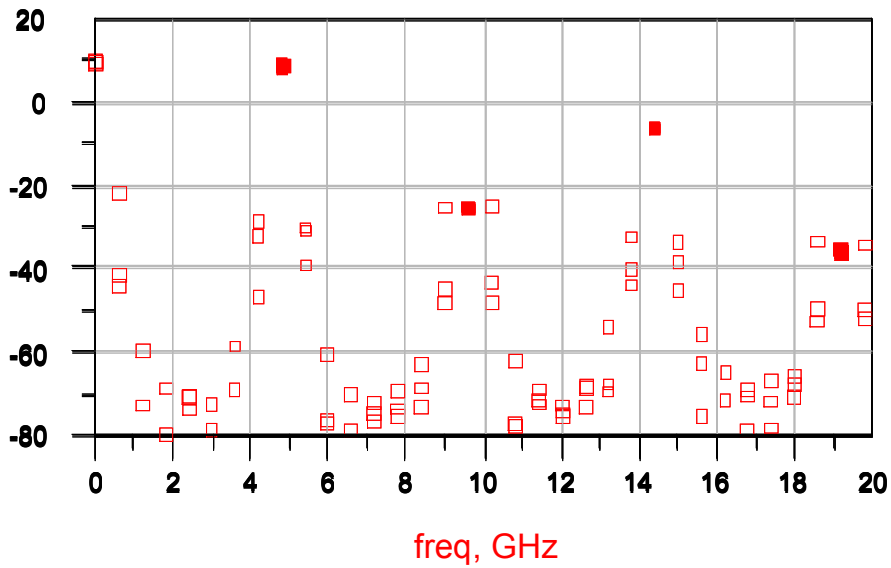


- example of measured data:

$v - i$ port1



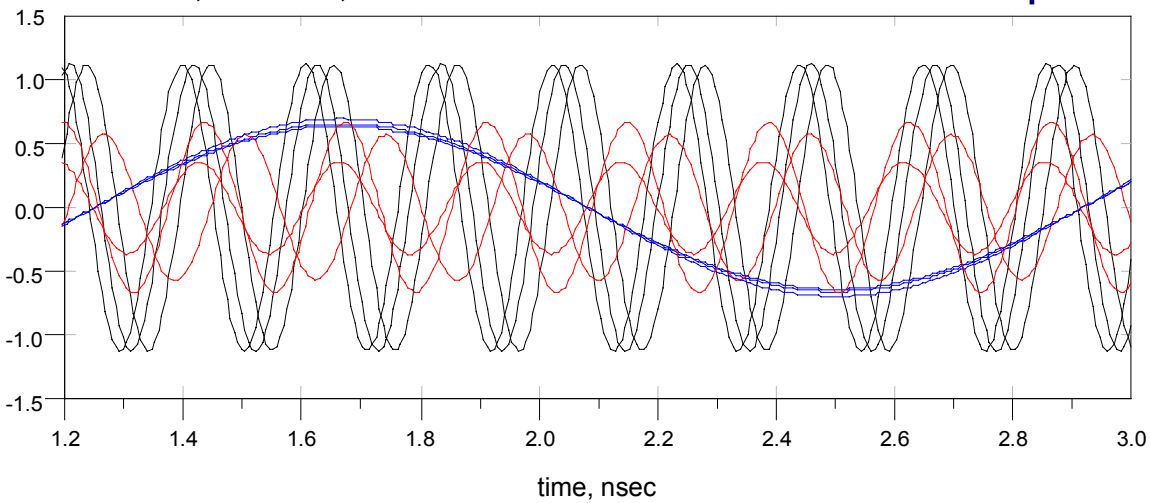
$v - i$ port2



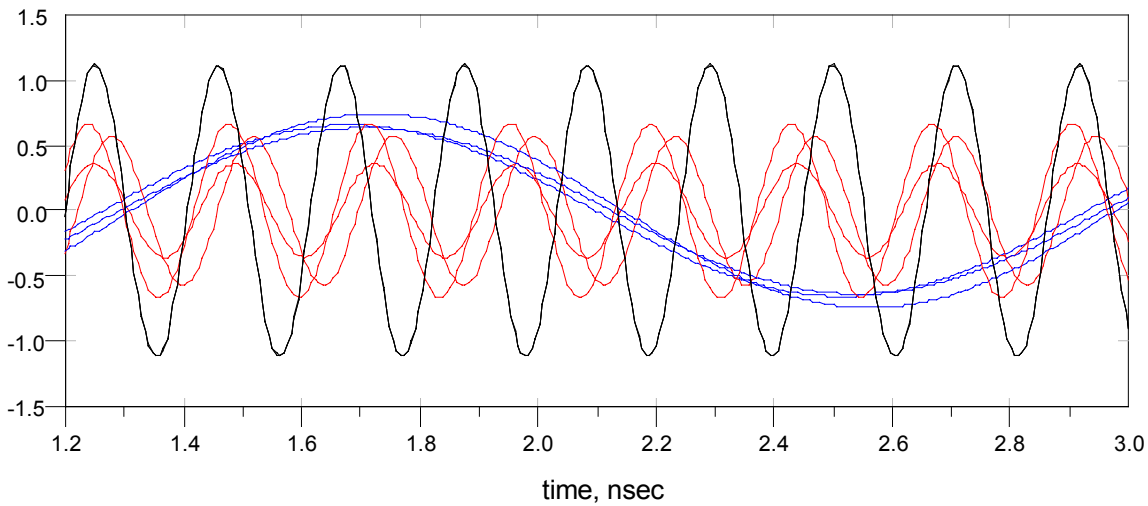
$$[\mathbf{I}^{(1)}, \mathbf{I}^{(3)}, \ldots, \mathbf{I}^{[2(2N+1)]}] = \mathbf{Y} \times [\mathbf{V}^{(1)}, \mathbf{V}^{(2)}, \ldots, \mathbf{V}^{[2(2N+1)]}]$$

pre-processing

example of LO \ v1,0 \ v1,1measured with 600MHz as phase reference



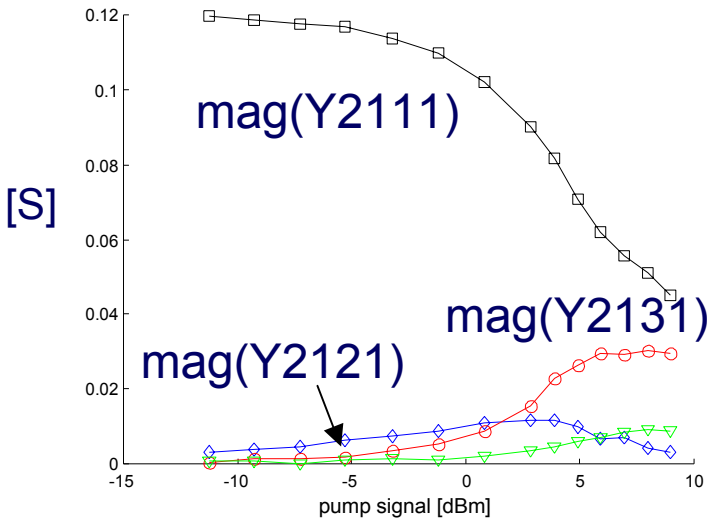
after the pre-processing all the measures are locked to the LO signal



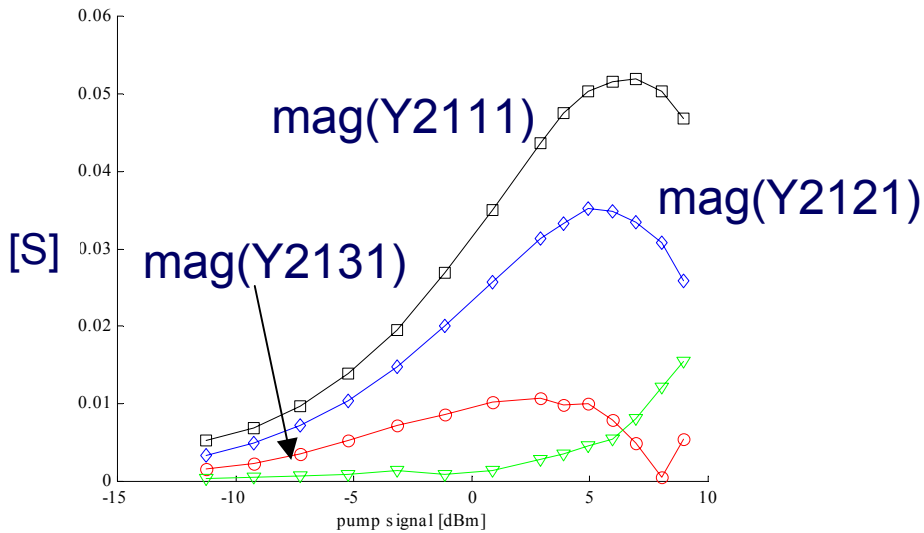
NB: v1,0 and v1,1 are scaled in amplitude for the sake of the representation

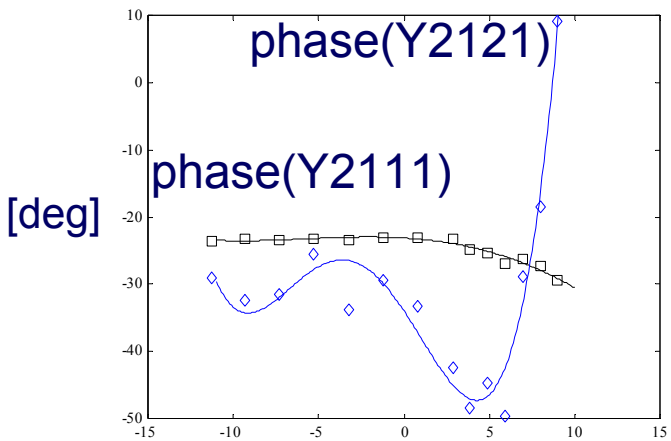
experimental results

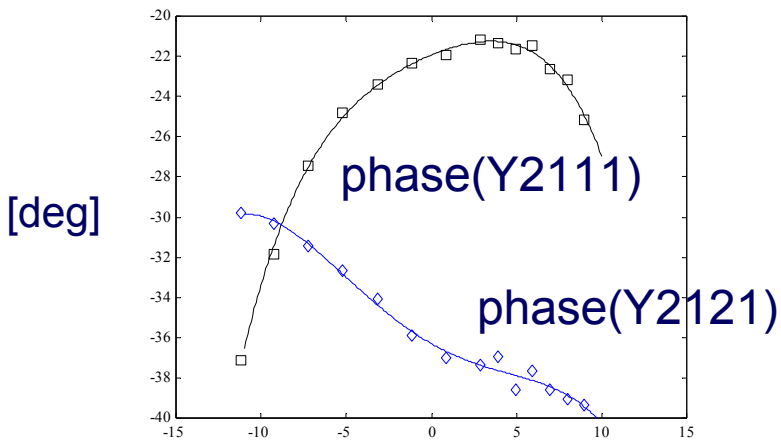
@Id=Idss/2



@ Vgs=Vp

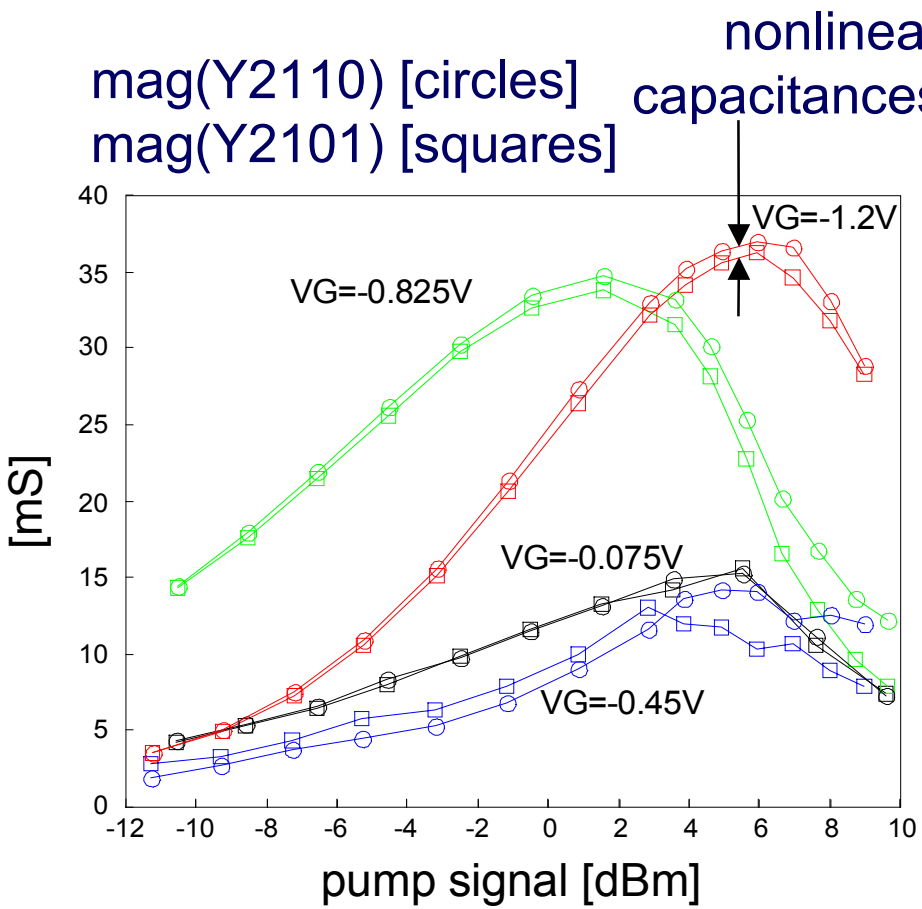




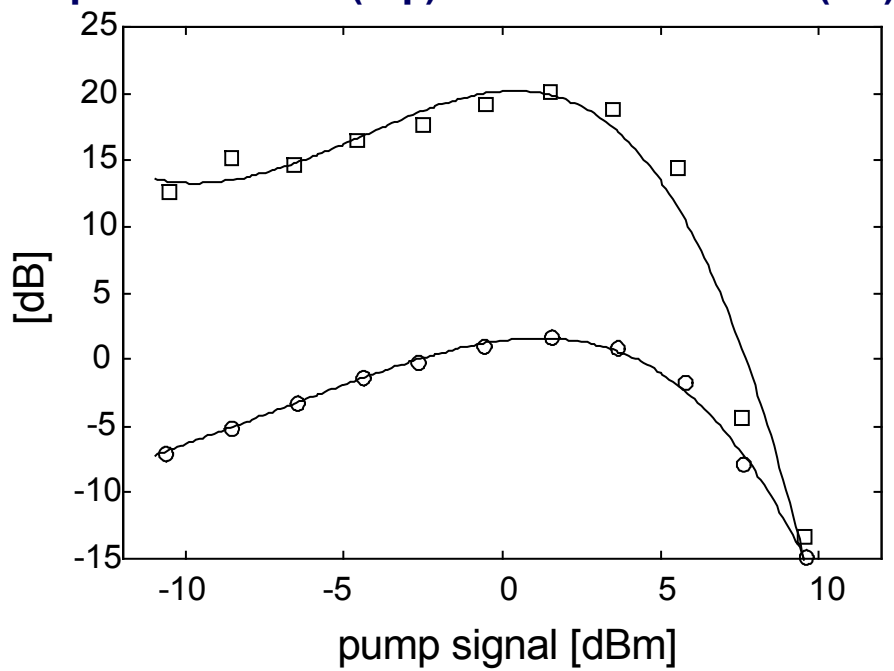


experimental results

- 0.2um P-HEMT LO: 4.8GHz; RF\IF=600MHz\5.4GHz



maximum conversion gain @ Vg=-0.1V
up-conversion (sq.) down-conversion (cir)



conclusions

- a F.D. description of an electron device under large signal pumping, through the admittance conversion matrix has been provided
- the CM is evaluated directly from NVNA measurements eliminating the need for accurate device models and large signal analysis, in mixer design
- the validation of the proposed method is obtained through circuit level comparison and by VNA measurements where applicable
- the extension of the method to the mixer linearity is ongoing