Estimating the Best Linear Approximation in electronic circuits

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The Best Linear Approximation (BLA) is a useful tool for the design and analysis of non-linear electronic circuits [1], [2]. It allows to look at the performance of the non-linear circuit from the familiar linear world which gives an intuitive look into the circuit without having to simplify the class of excitation signals or using special models to describe the system.

Looking at the complete behaviour of a circuit requires a port-based approach, where both voltages and currents are considered at each terminal of a circuit. The port-based approach leads to the familiar impedance (Z), admittance (Y) or scattering (S) parameters, which use a Multiple-Input Multiple-Output (MIMO) system to describe the full behaviour of the circuit (Figure a). Introducing the BLA into this framework means that we need a fast and reliable way to determine the MIMO BLA of a sub-circuit in an electronic circuit (Figure b).

The identification of the MIMO BLA is a well-studied problem [3] but, when we try to apply the default techniques to electronic circuits, extra questions arise:

- Determining the MIMO BLA requires two sources. Where to place the extra sources?
- Are voltage sources the best option, or should current sources be used?
- Can we tell something about the circuit behaviour outside of the main excitation band?
- How can we minimise the amount of simulation time?

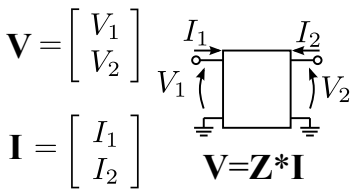
With simulation examples, we illustrate the issues that pop-up when trying to apply the theory blindly. Then we'll show how the BLA of a sub-circuit is properly determined.

References

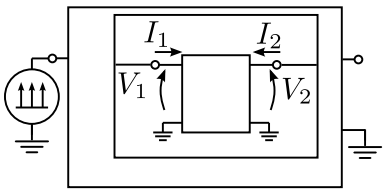
[1] A. Cooman and G. Vandersteen, "Distortion contribution analysis by combining the best linear approximation and noise analysis," in *To be published in the proceedings of the 2014 International Symposium on Circuits and Systems (ISCAS 2014)*, 2014.

[2] L. De Locht, "Measuring, modeling and realization of high-frequency amplifiers," Ph.D. dissertation, Vrije Universiteit Brussel (VUB), 2007.

[3] R. Pintelon, G. Vandersteen, J. Schoukens, and Y. Rolain, "Improved (non-)parametric identification of dynamic systems excited by periodic signals the multivariate case," *Mechanical Systems and Signal Processing*, vol. 25, pp. 2892 – 2922, 2011.



(a) Using a port definition to describe an electronic system, leads to a MIMO representation



(b) The goal is to find the MIMO BLA of a sub-circuit embedded in a bigger circuit.

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