Signal Processing Techniques for the Linearization of Concurrent Multiband Communications Systems

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***Abstract*—This work focused on digital predistortion for power amplifiers. Memoryless modeling and the performance of some component selection techniques on a model validation and on a PA linearization have been the main topics of this research. Results is commented in this paper and some graphics are shown. In addition, the student explains his future career plans and gives his experience on attending to a MTT-S Sponsored Conference.**

***Index Terms*—Signal processing, Power amplifiers (PA), Digital predistortion (DPD), Compressed sensing techniques.**

I. INTRODUCTION

MOBILE base stations use a large amount of energy to transmit information. The device that consumes most of the energy is the PA. PAs have a particular feature in their operation: their efficiency is greater at high powers, where the distortion appears, which is an undesirable effect. Therefore, if the device needs to be efficient, it is necessary to operate at a high power. On the other hand, new communication standards within the fourth and fifth generation of wireless mobile telecommunications technology (4G and 5G), define signals with a high peak-to-average power ratio (PAPR). These excursion points of power together with the distortion of the PA at a high power make it necessary to decrease the operating point, with the corresponding decrease in efficiency of the communications device. This effect has captured the interest of the scientific community in the recent years, when DPD has been presented as a very promising solution. The DPD consists of processing the signals transmitted in a way that when they are distorted again by the PA, the cascade block of the DPD and PA results in a nearly linear system. In this way, all the desirable requirements for a communications system are met: operation at a high power for ensuring energy efficiency and a high-fidelity device, which allows the use of the new transmission systems.

The most widely used structured for the DPDs are based on Volterra models, which although allow to obtain the DPD straightforward, are characterized by having a large number of coefficients, and therefore having a high computational complexity. To enable the design of DPD within Volterra models, two different approaches are available: the pruning of the model by choosing which coefficients must be active a priori, and the development of component selection algorithms, known as compressed-sensing (CS) techniques.

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II. EXPERIMENTAL SETUP AND RESULTS

During this scholarship, all the needed steps in the analysis of a PA and the development of some DPD device have been studied and performed. First, the student worked with the setup shown in Fig. 1., where a 15-MHz OFDM signal according to the LTE-downlink standard at 3.6 GHz was used as the input and the output of the PA was measured. After that, the data was processed to synchronize the input and the output signal. The

Fig. 1. Measurement setup. From left to right: (back) a vector signal generator SMU200A, between two power supplies, one for the PA and the other for the preamplifier, and vector signal analyzer PXA-N9030A; (front) Minicircuit's ZHLA42W preamplifier, Cree's CGH40010 evaluation board, directional coupler and attenuators.

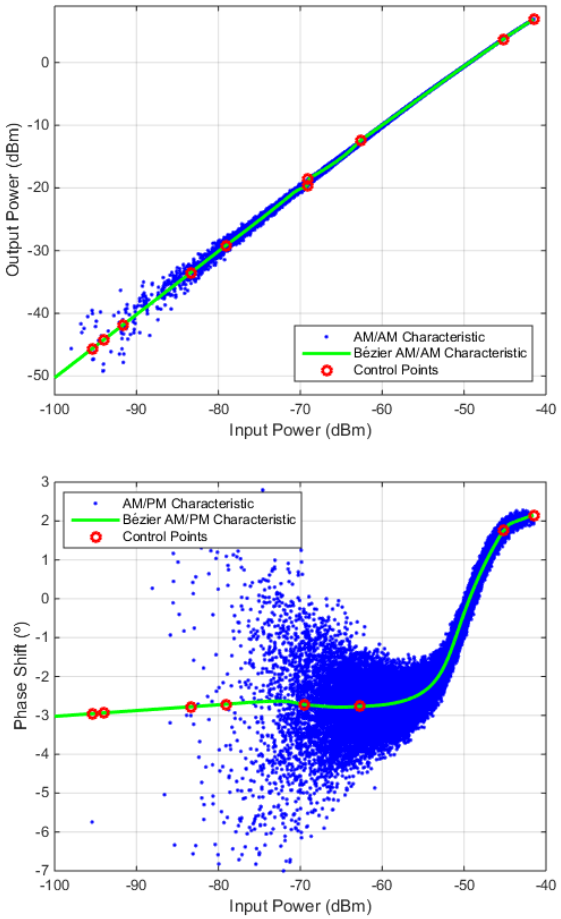

Fig. 2. AM/AM and AM/PM characteristics of the outputsignal. In blue, the original data; in green, the Bezier Curve adjustment highlighting in red the start and end of the obtained segments.

next step was modeling the PA. To do this, a new memoryless modeling approach was developed using Bézier Curves [1] (Fig. 2). Apart from this, a Full-Volterra Model [2] with a memory depth of $Q = 3$ and a model order of $2P - 1 = 13$ was used, and as this model has many coefficient, the performance of some component selection techniques in the model validation was compared, such as the Orthogonal Matching Pursuit (OMP) [3], the Iterated Ridge Regression (IRR) [4] or the Principal Component Analysis (PCA) [5].

On other approach, a 5G waveform candidate was used to generate another input signal for the PA. This way, the test signal was designed according to the FBMC format with a bandwidth of 15-MHz. Only the 1.5% of the samples with the highest absolute value at the output are used in the model regression, which was a Generalized Memory Polynomial (GMP) model. and compared the IRR and OMP performances in the PA linearization [4] (Fig. 3).

The main results obtained in this research have been presented in the XXXII and XXXIII Spanish National Conferences of the International Union of Radio Science (URSI) [1] [2] and the 91st ARFTG Microwave Measurement Conference (ARTFG) [4].

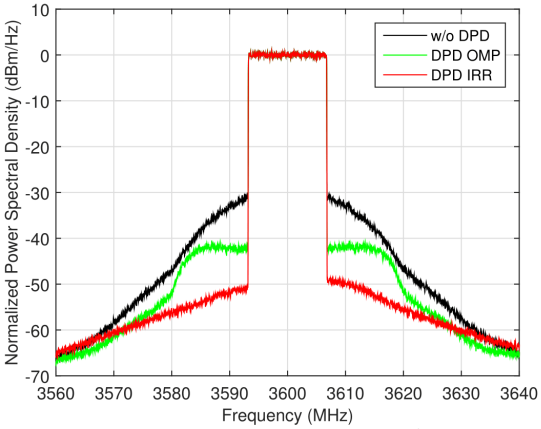

Fig. 3. Normalized Power Spectrum Density of the output signal obtained by the different techniques that have been analyzed, where they both selected 10 coefficients of the model.

III. CONCLUSION

A. *Future career plans*

The student is expected to graduate his B.Sc. degree in electrical engineering, majoring in communications systems, at the University of Seville in September 2018. He plans to pursue a master's degree in electronics, signal processing, and communications, starting in October 2018. Also, he is considering following a Ph.D. program.

B. *Impression on MTT-S Sponsored Conference*

As he has been able to attend to the 2018 International Microwave Symposium in Philadelphia, the student has made the most of all the time spent in the congress, attending to different technical sessions, watching around the booths in the Industry Exhibition, and connecting with new people at the networking events in a multicultural and diverse scenario. He is so thankful to the MTT-S and he is looking forward to submitting new research to the 92nd ARTFG and the IMS 2019.

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