A Digital Predistortion Technique Based on a NARX Network to Linearize GaN Class F Power Amplifier

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Abstract - This work presents a novel Digital Predistortion (DPD) scheme based on a NARX network, suitable for linearizing power amplifiers (PAs). The NARX network is a Recurrent Neural Network (RNN) with embedded memory that allows efficient modeling of nonlinear systems. Its neural architecture is very effective to model long term dependences, such as the typical memory effects of PAs. To demonstrate the feasibility of the NARX network as a DPD system, a GaN class F PA with two LTE signals with 5 MHz of bandwidth is used. Experimental results show a distortion correction better than 16 dB.

NARX Neural Network

The NARX neural network has a recurrent architecture based on a class of discrete-time systems using the delayed copies of the input signal as exogenous inputs (NARX), which is mathematically represented by:

\[ y(t) = f(u(t), y_1(t-d_1), \ldots, y_{m}(t-d_{m})), \]

Where, \(y(t)\) : the outputs and inputs of the system at time \(t\), respectively, \(de\) and \(dy\) : the embedded input and output memory, respectively, \(f\) is a nonlinear function that represents the behavior of the system to be modeled.

The DPD model with NARX uses an indirect learning architecture and linearizes the memory effects of the PA.

Experimental Results

The experimental setup was implemented to linearize a GaN class F PA. The tests are performed under a simulation environment with hardware verification. The GaN class F PA is designed at 2 GHz. The input signal is an LTE with Carrier Aggregation of two contiguous 2x5 MHz components carriers. The DPD model with NARX was validated using a test environment architecture with an embedded memory in the input and output that proves to be highly effective to model long-term dependences, possesses fast convergence and a good generalization performance. The proposed DPD model has the capability of modeling the nonlinearities and the long-term memory effects of the PAs. Experimental results with a class F PA using two contiguous LTE signals centered at 2 GHz, verify the usefulness of the NARX network as an effective DPD scheme for class F PAs.

Conclusions

This paper presents a DPD technique based on a NARX neural network to linearize class F PAs with high nonlinearities and long-term memory effects. The NARX network has a recurrent neural architecture with embedded memory in the input and output that proves to be highly effective to model long-term dependences, possesses fast convergence and a good generalization performance. The proposed DPD model has the capability of modeling the nonlinearities and the long-term memory effects of the PAs. Experimental results with a class F PA using two contiguous LTE signals centered at 2 GHz, verify the usefulness of the NARX network as an effective DPD scheme for class F PAs.

References