

# Digital Distortion with Low Precision ADCs

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**Abstract**—Digital Predistortion (DPD) is a popular technique for linearizing a power amplifier (PA) to help reduce the spurious emissions and spectral regrowth. DPD requires the learning of the inverse PA nonlinearities by training on the output of the PA. In practical systems, the analog output of the PA will have to go through an analog-to-digital converter (ADC) so that training can be done on a digital processor. The quantization degrades signal quality and may limit performance of a DPD learning algorithm. However, a lower resolution ADC may cost less and allow for less computational complexity in the digital processing. We study this tradeoff to try to find how much precision is needed in DPD systems.

## I. INTRODUCTION

The power amplifier (PA) is a component of wireless systems that has a nonlinear transfer function. The nonlinearities are undesirable in that they lead to distortions such as spectral regrowth around the main carriers and intermodulation distortions (IMDs) in scenarios with multiple, noncontiguous carriers. This is exacerbated with modern signals such as OFDM with high PAPR.

Digital predistortion (DPD) is a method for linearizing a power amplifier (PA). With DPD, the nonlinearities are estimated so that they can be corrected before the PA with their inverse. To do this, we must train our predistorter by observing the signal after the PA. In practical situations, we need a feedback path after the PA that has a downconverter and an ADC. For wide bandwidth signals, the sampling rate of the ADC must be fast. In mobile applications where power and cost are a concern, one option for reducing the complexity of the system is to use a low precision ADC.

This is a common thing being explored in MMWave and massive MIMO

In this paper, we test the performance of our previous DPD solutions for varying ADC precision.

## II. FULL-BAND DPD

Most DPD is a variation of what we refer to as full-band DPD where the entire transmit band near the main carriers is linearized. This can reduce the magnitude of multiple spurious emissions such as the third and fifth intermodulation products and the spectral regrowth around the main carriers. However, this comes with a considerable computational complexity especially as the spacing between the carriers becomes large. Moreover, the cost of the ADC rapidly increases as the sampling rate grows.

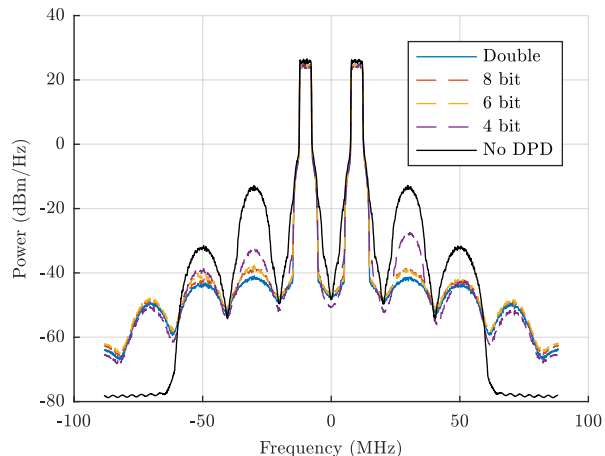


Fig. 1. PSD output when performing full-band DPD with a low precision ADC feedback path. Here, performance for the 8 bit and 6 bit ADCs are similar with about 2 dB less IM3 suppression when compared to the double precision PA simulation.

One potential way to ease this cost and reduce complexity with only a small loss in performance is to reduce the precision of the ADC.

## III. SUB-BAND DPD

An alternative to the full-band DPD is what the authors refer to as sub-band DPD. With this method, one targets specific sub-bands such as an intermodulation product to suppress. This has the effect of drastically reducing sample rates which in turn reduces the running complexity of the algorithm. This method also provides freedom in the sense that specific sub-bands can be targeted as needed.

The complexity can further be reduced if we limit the resolution of the ADC.

## IV. WARPLAB TESTING

## V. CONCLUSION

The conclusion goes here.

## REFERENCES

- [1] H. Kopka and P. W. Daly, *A Guide to L<sup>A</sup>T<sub>E</sub>X*, 3rd ed. Harlow, England: Addison-Wesley, 1999.

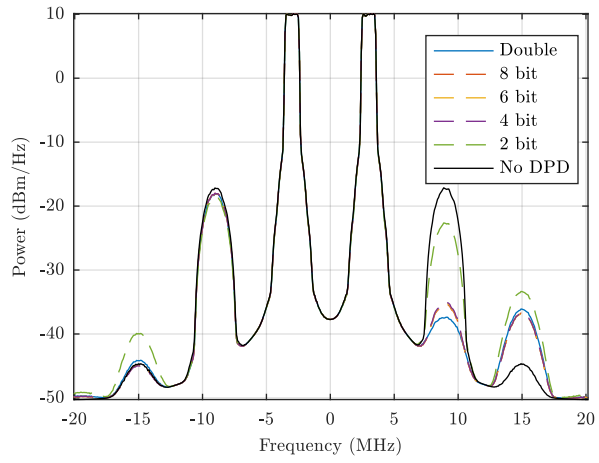


Fig. 2. PSD output when performing sub-band DPD with a low precision ADC feedback path. Here, performance for 8, 6, and 4 bit observations are similar with about 2 dB less IM3 suppression when compared to the double precision PA simulation.