# Overview of Synergetic OFDM Crest Factor Reduction and Digital Pre-Distortion for RF PAs

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***Abstract*— Digital baseband pre-distortion (DPD) is used to linearize nonlinear RF PAs, crest factor reduction (CFR) to increase the maximum output power level of RF PAs. Together they result in increased output power with maintained, or even, better linearity. This paper discuss some of the techniques for DPD and CFR methods currently under investigation. Measured results for a class-AB PA using OFDM signals indicate a possibility to increase the power added efficiency (PAE) by at least 15%-points, from 30%to 45%, and a power output increase of 6 dB while maintaining specified ACLR requirements.**

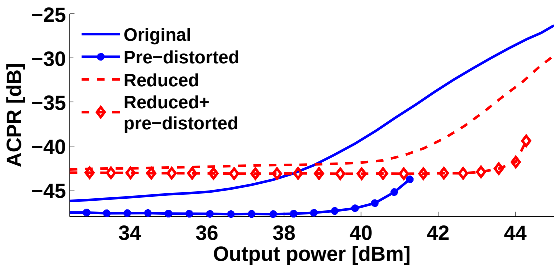


Fig. 1. The ACPR as function of measured output power.

The trade-off between efficiency and linearity in radio frequency (RF) power amplifiers (PAs) has for a long time been a major issue. Much of the problems stems from the use of signals with high crest factors (CRs). Methods to reduce the CF exist, ranging from the simpler clip-and-filter, to partial transmit sequence (PTS) [1] and selective mapping [2], and CFR using convex optimization [3]. This paper utilizes the approach for CFR in [4] with conventional digital pre-distortion (DPD) according to [5].

Reducing the CF of an orthogonal frequency division multiplexing (OFDM) signal is done by introducing extra carriers and by intentionally distorting the constellation symbols. The amount of introduced distortion is fully controllable. For details on algorithm the reader is referred to [3], [4].

Baseband DPD [6] has been applied to RF PAs for a number of yearsand the method is fairly mature. In short, a pre-inverse of the PA is extracted and then implemented to operate on the input signal to the PA. The most essential operation of the DPD is to expand the signal when the PA enters into compression.

A 20 MHz wide OFDM signal using 16-QAM with 48 data carriers and a FFT size of 64 was used in these measurements. Four cases are tested: 1) No CFR, no DPD, 2) CFR, no DPD, 3) No CFR, DPD, and 4) CFR and DPD. The ACPR values for these cases are shown as functions of the output power are shown in Fig. 1.

The original signal fails the 40 dB ACPR limit at 39 dBm, if DPD is added it can be operated up to 41.5 dBm. At higher power levels the DPD looses functionality due to the compression of the PA and generates signals with unreasonable CFs. This is currently undergoing investigation.

Due to the additional carriers the ACPR of the original CFR signal is worse than that of the signal without CFR, -43 dB compared to -47 dB. The signal with only CFR passes the 40 dB limit if the power is kept below 42 dBm. With DPD this power level is increased to 44 dBm. The difference in PAE at 41 dBm and 44 dBm output power is more than 15%-points which by far outweighs the power wasted in the extra carriers.

Methods to further increase the possible output power are to control the signal peaks in the predistorted input signal to the PA. Two methods are proposed to do this in [5]: CRF after DPD and joint CRF-DPD extraction.

## References

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