Wireless Communication Systems Laboratory

Elective Lab (#9): Understanding nonlinear distortions in the RF front end

I. PA AND LNA NONLINEARITIES

The objective of this part is to understand the PA and LNA nonlinearities and their effects on the communication systems.

Following items can be observed;

- PA and LNA nonlinearities
- Spectral re-growth
- In-band interference
- Peak-to-average power ratio
- Multi carrier and single carrier signaling
- CDMA (multiple codes)
- Comparison of single carrier and OFDM (with different number of carriers) systems and their performances under PA or LNA nonlinearities
- Observation of PAPR and corresponding performance of OFDM systems for various number of FFT sizes

II. IQ MODULATOR PROBLEMS

IQ errors can be introduced by either Agilent signal studio or Matlab:

- DC Offset
- IQ gain imbalance
- IQ quadrature offset

The effect of the errors can be observed separately with multi-carrier (OFDM) and single carrier systems.
III. LOCAL OSCILLATOR- FREQUENCY OFFSET

Carrier frequencies of either transmitter or receiver can be intentionally changed to simulate and frequency offset error. It should be noted that there is always a residual frequency offset between transmitter and receiver even though the carriers are set to the same frequency values.

This part can be performed for both single and multi-carrier (OFDM) systems.

In addition, you can connect one of the sources to the other device and control the source to introduce controlled offset. This way, you will know the exact frequency offset and its effect on the system.

IV. ADC/DAC ISSUES AND DYNAMIC RANGE

Following items can be studied;

- Effect of ADC dynamic range and its relation to quantization error
- Analysis of the receiver performance depending on the dynamic range configuration
- Quantification of quantization error and relating it with EVM
- Relating this with automatic gain controllers (AGCs) which are used in real wireless systems.

V. SAMPLE TIMING OFFSET

An intentional sample timing offset can be introduced at the receiver to observe the performance of the receiver by performing demodulation analysis (eye diagram, constellation, etc)

Please note that you should be careful while setting the ‘result length’ parameter in the digital demodulation properties window. This parameter can be changed to see the change in the performance of the system with various sample timing offset errors.

You can introduce some offset at the sample of the receiver w.r.t. the transmitter sample rate and observe the performance. This is especially important if you use Nyquist filtering. You can look at the eye diagram and constellation in VSA digital demodulation analysis. You need to be careful in selecting “results length” in the digital demodulation properties pop-up menu. You can increase and decrease the results length and see how the performance is changing with various sample timing offset errors.