Lab 3. Signal distortions in communication systems

Purpose: To get familiar with the phenomena appearing in the radio channel and radio path and to be able to conclude of their presence in the signal from the implicit and explicit signal maps.

1. Task definition

In lecture 5, the following signal distortions, effects, and phenomena have been covered:

1. Carrier phase

2. Carrier frequency

3. Phase noise

4. Timing clock phase

5. Timing clock frequency

6. Additive white Gaussian noise

7. Amplitude noise

8. Signal level inaccuracies

9. Transmitter's IQ impairment DC-offset

10. Transmitter's IQ impairment gain difference

11. Transmitter's IQ impairment quadrature phase

12. Transmitter's IQ impairment time shift

13. Receiver's IQ impairment DC-offset

14. Receiver's IQ impairment gain difference

15. Receiver's IQ impairment quadrature phase

16. Receiver's IQ impairment time shift

17. Multipath

18. AM/AM nonlinearity

19. AM/PM nonlinearity

20. Clipping

Please choose at least ten from them and develop your experiments to show their impact on the signal. Compare time diagrams, constellations, and spectra of the original signal and the one to which chosen phenomenon is applied. These figures should show how the distortion affects each visualization way (or prove that they do not). You may also propose your way to demonstrate this effect on the signal.

2. An exercise of the increased complexity

- Design the block that adds a pre-distortion in the in-phase and quadrature channels. It should be placed in the modem at the transmitter side for the quadrature-phase impairment compensation. Prove its correctness analytically and in MATLAB.

- Design the block for the quadrature-phase impairment compensation in the receiver. Prove its correctness analytically and in MATLAB.

3. Report structure

1. Constellations, timing diagrams, and spectra of the signals to demonstrate the essence of the experiment.

2. Listings.

3. Conclusions.