Experiment 6: OFDM: A Multicarrier Modulation Technique

Aim: To compare the multicarrier modulation technique with single carrier modulation technique

1. Requirements: Matlab/Scilab/Python

2. Pre-Experiment Exercise

   2.1 Brief Theory:

   Wireless communication techniques can be divided into two categories: single-carrier modulations (SCM) and multicarrier modulations (MCM). Single-carrier modulation systems exploit only one signal frequency to transmit data symbols. In such a system a single carrier is employed for the entire bandwidth B. For this system symbol time T is given by T=1/B that means one symbol is transmitted every 1/B seconds. Single-carrier modulation have been widely used in many wireless communication systems such as 1G, 2G, 3G wireless communication systems. Single-carrier modulations have some advantages: (1) Low peak to average power ration (PAPR), less sensitive to frequency shift and phase noise, which makes it easier for the time and frequency synchronizations.

   Whereas multicarrier modulation systems divide the whole frequency channel into many subcarriers and the high-rate data stream is divided into many low-rate ones transmitted in parallel on subcarriers. In MCM total bandwidth is divided into N subbands of bandwidth B/N. Each subcarrier can now be represented as –B/N, 0, B/N…. Block diagram of multicarrier modulation is given in Fig. 1.

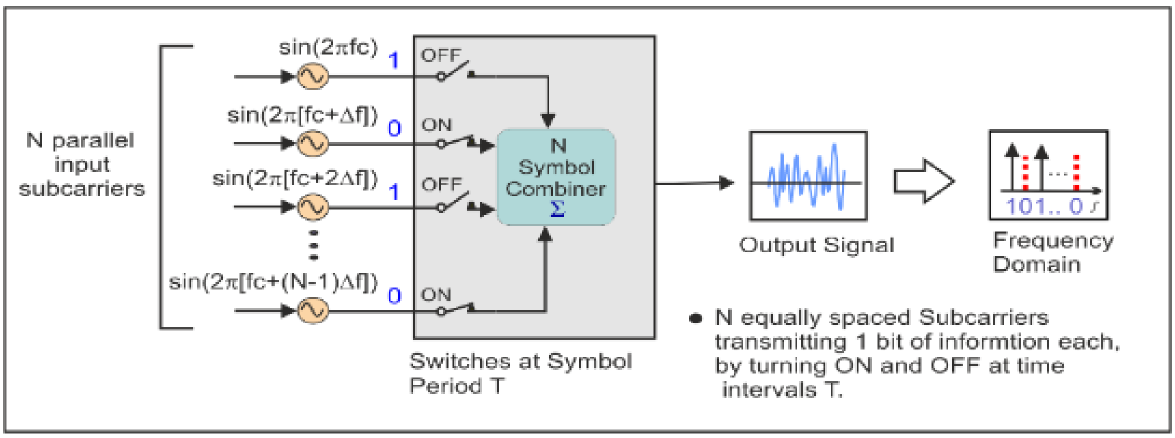

Fig. 1 Multicarrier Modulation System

Orthogonal Frequency division multiplexing (OFDM), also known as multicarrier transmission or modulation, uses multiple carrier signals at different frequencies, sending some of the bits on each channel. This is similar to FDM (Frequency Division Multiplexing) however in the case of OFDM; all of the sub channels are dedicated to a single data source. For OFDM case IFFT is used at the transmitter to accomplish this, which does not exist in Single carrier case. In OFDM bitstream first mapped into a complex value signal vector, S = [S0,S1,...,SN-2,SN-1] ^{T} , where N is the number of sub-carriers, which is transmitted in parallel. In the discrete time domain, the nth IFFT symbol is given by eq(1)

$$s_n = \frac{1}{N}\sum_{k=0}^{N-1} s_k.\exp\left(j\frac{2\pi nk}{N}\right), \quad n = 0,1,\ldots,N-1 \tag{1}$$

3. Laboratory Exercise
Procedure

1) Write a simulation program to find the OFDM samples for the given OFDM Symbols

5. Post-Experiment Exercise

5.1 Conclusion

5.2 Questions:

a) Draw the explain the block diagram of the OFDM Transmitter and list out the advantages of OFDM and briefly explain them

b) What do you understand by PAPR and explain the effect of PAPR