Minimization of Peak to Average Power Ratio in an OFDM System by using Selective Mapping Technique

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***Abstract*—orthogonal frequency division multiplexing (OFDM) is very efficient technique for providing high quality of service by converting the frequency selective channels to the group of flat fading channels one channel across the each subcarrier. It reduces inter symbol interference (ISI) caused by the delay spread of wireless channel. But the major drawback of is OFDM its peak to average power ratio (PAPR).In this paper we apply a technique to reduce PAPR is selective mapping (SLM).Complementary Cumulative Distribution Function (CCDF) is used to measure the probability of PAPR*.**

Keywords*— Orthogonal frequency division multiplexing(OFDM), Frequency selective channel, Flat fading channel; inter symbol interference (ISI), Peak to average power ratio(PAPR); Selective mapping(SLM), Complementary Cumulative Distribution function(CCDF)

I. INTRODUCTION

OFDM forms the basis of 4G (fourth generation) wireless communication system. Many application demands data rates of higher orders for transmission over mobile or wireless channels. Digital terrestrial mobile communication, Digital Audio Broadcasting (DAB), Digital Video Broadcasting (DVB), wireless asynchronous transfer mode (WATM) uses OFDM. OFDM is of great interest by researchers and research laboratories all over the world. It has already been accepted for the new wireless local area network standards IEEE 802.11a, High Performance LAN type2 (HIPERLAN/2) and Mobile Multimedia Access Communication (MMAC) system. Due to increase in data rate symbol duration decreases which results in ISI. To alleviate the effect of ISI, cyclic prefix in introduced. As long as the duration of OFDM symbol after adding the cyclic prefix is longer than the channel delay spread, OFDM offers ISI free transmission. OFDM is a technique which employs splitting of high rate data streams into a number of lower data rate streams that are transmitted parallel over a number of subcarriers. OFDM provides impunity to impulse noise and multipath fading .OFDM modulation includes Inverse Fast Fourier Transform. (IFFT) and Cyclic Prefix interpolation at the transmitter end. In OFDM receiver, Cyclic Prefix is removed before data packets are sent to the FFT demodulation .The main problem of multicarrier modulation is that it exhibits a high PAPR (peak-to average-power-ratio). This means that the peak values of some of the transmitted signals could be much larger than the typical values.

II. PAPR OF OFDM

Let us consider information symbol X(0),X(1),X(2) …..X(n-1) having amplitude ±a each. This information symbols are loaded on to the subcarriers. Hence transmitted samples are x(0),x(1),x(2)……x(N-1) which are IFFT samples of information symbols . k^{th} samples are given by

$$X(K) = \frac{1}{N}\sum_{i=0}^{N-1} X(i)\, e^{j2\pi ki/N}$$

Average power =

$$E\{|x(k)|^2\} = \frac{1}{N^2}[\sum_{i=0}^{N-1} E\{x(i)^2\}\ E\{|e^{j2\pi ki/N}|^2\}]$$

$$E\{|x(k)|^2\} = \frac{1}{N^2}[\sum_{i=0}^{N-1} E\{x(i)^2\}$$

$$= \frac{1}{N^2}[\sum_{i=1}^{N-1} a^2]$$

$$= \frac{1}{N^2} a^2.N$$

$$= \frac{a^2}{N}$$

Hence average power of transmission = $\frac{a^2}{N}$

Peak Power:

$$X(0) = \frac{1}{N}\sum_{i=0}^{N-1} X(i)\, e^{j2\pi 0i/N}$$

$$= \frac{1}{N}[\sum_{i=0}^{N-1} x(i)]$$

$$= x(0)=x(1)=\ldots\ldots.\ x(N-1) = +a$$

$$= \frac{1}{N}\sum_{j=0}^{N-1} X(i) = \frac{1}{N}\sum_{i=1}^{N-1}|a|^2$$

$$= |a|^2 = a^2$$

PAPR=Peak power / average power

$$= \frac{a^2}{\frac{a^2}{N}} = N$$ (where N is the number of sub carrier)

Hence PAPR in the OFDM is significantly higher. However PAPR increase with increase in the N that is number of sub carrier. High PAPR in an OFDM system essentially arises due to IFFT operation because data symbol across the sub carrier can add up to produce high peak value signal .In an OFDM with 512 subcarrier and Bipolar Phase shift keying (BPSK) modulation the PAPR at the output as high as 10db. In an OFDM where peak deviation about average is significantly high the signal level moves outside the dynamic range. Hence the high PAPR results in amplifier saturation, leading to the inter-carrier interference. A large value of PAPR leads to the increase in the complexity of the A/D and D/A converters .PAPR of OFDM system is characterized using Complementary Cumulative Distribution Function.

III. PAPR REDUCTION TECHNIQUES

There are number of methods has been developed to reduce the PAPR reduction .In this paper we discuss Selective Mapping technique which is efficient method to reduce the PAPR in OFDM and discuss the characteristics of the PAPR with the CCDF . A large number of set of data vectors all representing the same information are generated by the SLM technique .A data block resulting the lowest PAPR is selected.

IV. SELECTIVE MAPPING TECHNIQUE (SLM)

In particular SLM technique whole set of signal represent the same signal but form it most favourable signal is chosen related to PAPR transmitted. The side information must be transmitted with the chosen signal. This technique is probabilistic based will not remove the peaks but prevent it from frequently generation. This scheme is very reliable but main drawback that is side information must be transmitted along with chosen signal.

V. RESULTS AND DISCUSSION

Results are shown for the case of a single OFDM block and 16 clusters each composed of 16 subcarriers. The transmitted signal is oversampled by a factor of four. Simulations have shown that this is sufficient to capture the peaks. In the results which follow, 100 000 random OFDM blocks were generated to obtain the CCDF's. We assume 256 subcarriers throughout and QPSK data symbols. The unmodified OFDM signal has a PAPR which exceeds 10.4 dB for less than 1% of the blocks. By using the SLM approach with the optimum binary phase sequence for combining, the 1% PAPR reduces to 9.5 db.

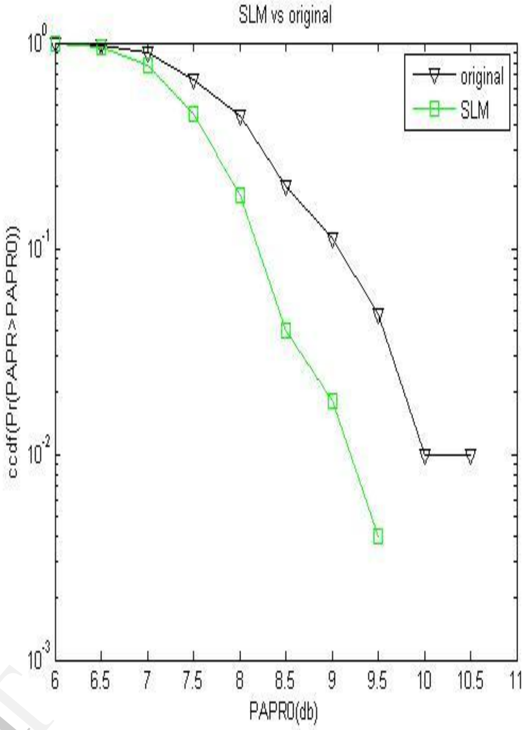

Fig 1. CCDF of PAPR obtained with the SLM technique

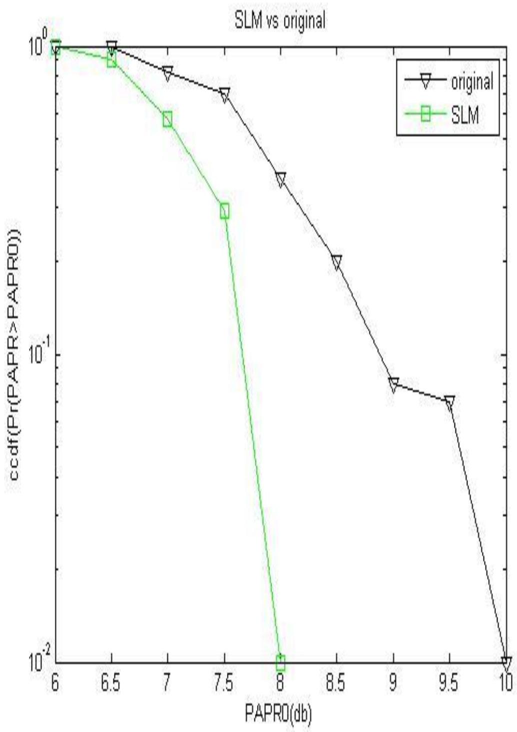

Fig 2. CCDF of PAPR obtained with the SLM technique

As we again change the value of M=8 with SLM approach taking into account, we get better result in the reduction of PAPR. The graph is taken from Mat Lab. It shows that as we increase the value of M, we can have much efficient signal containing less PAPR. In this case signal approaches to 7.8 db .This is a distortion less and effective technique used for the PAPR reduction in OFDM. As the name indicates that one sequence has to be selected out of a quantity of sequences. According to this concept of OFDM transmission we should make a data block considering N number of symbols from the constellation plot. Where N is the number of sub carriers to be used. In SLM, the input data sequences have been multiplied by each of the phase sequences to generate alternative input symbol sequences. Each of the alternative input data sequences is made the IFFT operation, and then the one with the lowest PAPR is selected for transmission. Therefore, the ability of PAPR reduction in SLM depends on the number of phase factors V and the design of the phase factors.

VI. CONCLUSION

The resultant outcome after analysing the SLM techniques, it has been found that SLM technique has been adopted to reduce PAPR from OFDM signals by various researchers. An analytical study has been carried out on a reducing PAPR by SLM technique. It has been seen from the graph that SLM has an upper edge over general OFDM signal.

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