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# REVIEW OF TECHNIQUES USED IN OFDM COMMUNICATION SYSTEM TO REDUCE PEAK TO AVERAGE POWER RATIO (PAPR)

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***ABSTRACT***

***This paper analysis the basics of OFDM communication system to provide in depth into strategies opted to tackle PAPR. The study of OFDM communication system along with strategies to handle PAPR helps future researchers to use OFDM communication system commonly and effectively. At initial stage OFDM communication system uses analog signals but now days signals are in the digital form. In order to improve transmission single carrier systems are replaced with multi carrier systems like OFDM and CDMA. In OFDM sub carriers are placed orthogonally to send the data from sender towards the receiver. Guard band present in OFDM reduce the noise present within the system. Large intensities of PAPR has adverse effect in such system. Due to multiple sub carriers present within OFDM (Orthogonal Frequency Division Multiplexing), high peak to power ratio (PAPR) is observed. The proposed work analyse techniques which are used to determine the cause and minimize adverse affect of PAPR.***

***Keywords- OFDM, analog , digital signals , CDMA, PAPR, Noise***

## I. INTRODUCTION

[1] High rate data channels are generally utilized in order to transfer the data from source to destination at rates. OFDM is one such communication system which converts spectrally efficient multiple carrier modulation into multiple lower data rate channels. Multiple lower data rate channels are spectrally orthogonal to each other. [2] Legion of applications exists associated with OFDM. Some of these applications include:

a. Digital Subscriber Line
b. High definition broadcasting system
c. High Speed cellular network
d. High speed optical communication

Along with the advantages disadvantages of OFDM also exists. [3] The main disadvantage is PAPR. This PAPR comes into existence due to large number of subcarriers. Non linear effects are introduced as a result of PAPR. The constraints on non linear network devices are also introduced. The non linear network devices includes analog to digital converter,

amplifiers and modulators. Hence reduction in PAPR in OFDM is critical. The Block diagram of OFDM is described in this section as

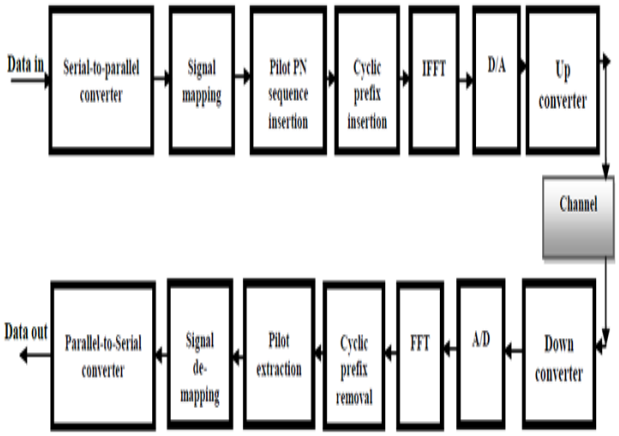


**Figure 1: OFDM Block Diagram**

Rest of the paper is organized as follows. Section II briefly describes PAPR. Section III describes PAPR reduction techniques where as next section describes comparison of all such techniques (through literature survey) used to reduce PAPR.

## II. PEAK TO AVERAGE POWER RATIO(PAPR)

[3]–[7] Presence of large number of independent sub carriers in OFDM gives rise to PAPR. Although PAPR of individual lower data rate channels may be lower but when considering as a whole then PAPR of entire system may exceed threshold value. The sum up of N coherent signals of same phase gives peak which is N times the average signal. The limitations of PAPR is described as under:

- Complexity enhancement in the process of analog to digital and digital conversion.

I. RF amplifier efficiency is reduced considerably.

## III. PAPR OF MULTI CARRIER SIGNALS

[8]Multi carrier signals used to transfer the data whose length considered to be N. Let actual data be represented through the vectors X={X1,X2,-----,Xn}. Duration of any signal present within set X is set to T.

One of the sub carriers is represented as { Fn, where n=0,1,2------N} . Since signals are orthogonal to each other hence

$F_n=n\delta f$.

Also f=1/NT.

NT is the duration of data block. The complex data block to be transmitted from source to destination is given as follows:

S(t)=1/√N ∑Xn e^2j∏nf where 0<=t<=NT

The PAPR in the transmitted signal is given as:

$$PAPR = \frac{Max|x(t)|^2}{\frac{1}{NT}\int |x(t)^2 dt}$$

Reducing the numerator is the target of every PAPR reduction mechanism. Many techniques are implemented to tackle the issue of PAPR in OFDM

and most of them deals with amplitude of various samples of x(t).

## IV. PAPR REDUCTION MECHANISMS

PAPR is an issue commonly found in OFDM communication system. Various techniques are discussed in this literature.

### *A. CLIPPING OF SIGNAL TECHNIQUE*

[9]This is one of the simplest mechanisms in order to reduce PAPR signal from OFDM communication system. The threshold value of amplitude is assumed in this case. Amplitude values exceeding this value is neglected and replaced by the threshold value. Signal clipping is represented through the following equation

$$F(x) = \{A \; when \; x > A \\ x \; when \; x < A$$

Clipping noise is introduced as a result of clipping of amplitude clipping technique.

### *B. COMPANDING BASED DISTORTION TECHNIQUE*

[10]This is a mechanism in which amplitude of a given signal is enlarged whoever enlarged signal remains the same. Using this method, the amplitude of the signal is redistributed after transformation process is complete. This results in reduction in PAPR value. Considerable noise is introduced within the signal as result of this technique. it is critical to choose commanding value which reduced the noise from transmitted signal. Signal to noise ratio is used to estimate the noise present within the signal transmitted.

### *C. SELECTIVE MAPPING FOR REDUCING PAPR*

[11]In this method, independent data blocks represented with M, are selected.

$$S_m = (S_m, 0, S_m, 1, S_m, 2, - - --, S_m, N-1)$$

$S_m$ represent the information obtained by multiplying original signal values by uncorrelated values $P_m$. The sequence is then fed into FFT simultaneously. PAPR is then calculated for each vector individually. The receiver needs to ensure that the signal is received accurately. The predefined values of individual vectors is already present with the receiver, by comparing the received signal against predefined values error can be calculated. The spectral efficiency however is reduced due to the above listed mechanism.

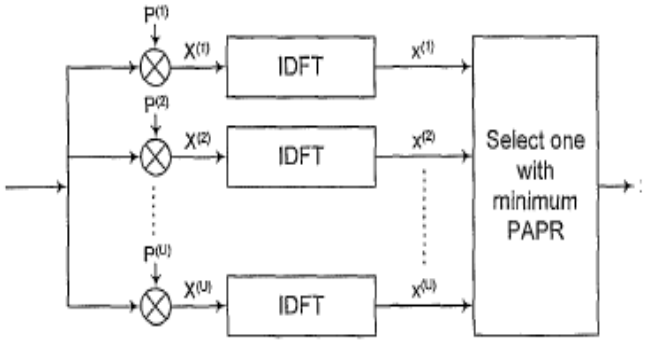


**Figure 2: Block diagram of SLM technique**

### *D. TRANSMIT SIGNAL PARTIALLY*

[12], [13]This technique involves transmission of signal through OFDM partially. This means signal is transmitted by dividing into sub sequence. Each sub sequence is assigned with the certain weight. The process is repeated until optimal value of weight is selected. Selecting optimal value selection could be difficult due variation in range of signals.

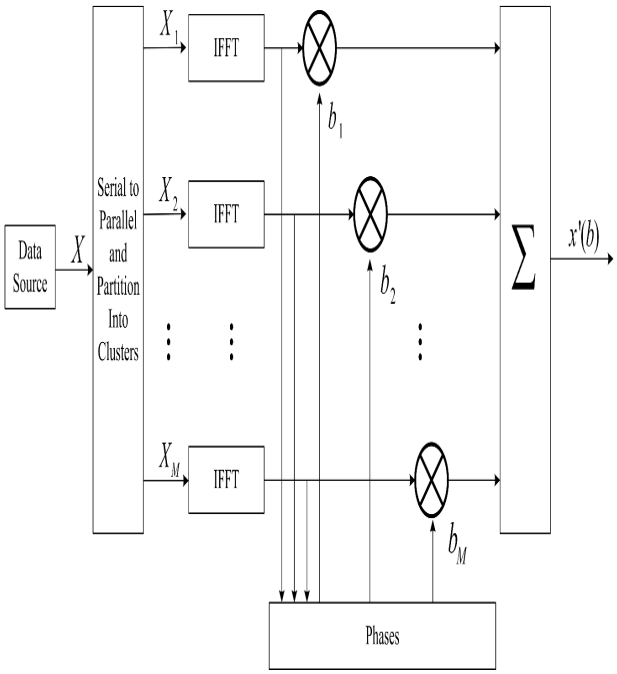


**Figure 3: Block diagram of Partial Signal Transmission**

## V. COMPARATIVE STUDY OF VARIOUS TECHNIQUES THROUGH LITERATURE SURVEY

This section describes comparative study of various techniques used for reduction in PAPR values through literature survey.

(Sheng ju ku et. Al.)[13] proposes a reduced complexity scheme for reducing PAPR in OFDM. Partial signal transmission is a technique used for this purpose. Signal is partitioned and transmitted. Every sub signal has certain weight associated with it. Optimal value of weight is selected by the repeated process of sub signal transmission. Complexity is reduced but weight factor selection is a difficult task due to large variation in signal.

(Sen-Hung Wang et. Al.)[14] suggests a low complexity PAPR reduction scheme in terms of selected mapping mechanism. Cycling shift mechanism in time domain is used to reduce the complexity in transmission process. The receiver ensures accurate receiving of signal by the use of comparator. The spectral efficiency of this mechanism is low hence some further modifications are required to enhance performance of this system.

(Seung-Sik Eom et. Al.)[12]proposed post inverse fast Fourier transform scheme to reduce PAPR from OFDM communication system. Phase rotation and cyclic shifting is performed in transmission hence reduce complexity in transmission process considerably. No side information regarding OFDM is required in this approach.

(Mottier et. Al.)[15]suggest the approach to reduce PAPR from the OFDM communication system. Single carrier signal is used in this case. symbols are rotated adaptively in this case and circular shift is

applied in time domain so that PAPR is reduced. A sequence of pilot symbol is used to determine the amount of phase shifting required to reduce the impact of PAPR in transmission in OFDM communication system.

(Hyun-Bae Jeon et. Al.)[16] suggests a parabolic peak cancellation mechanism to reduce PAPR from OFDM communication system. Peak cancellation is performed in time domain and FFT along with IFFT is not used. This scheme however when applied to FFT and IFFT, reduces iteration present within the FFT and IFFT.

(A. Hazmi et. Al.)[17] proposes PAPR reduction by the use of maximum correlation mechanism. This scheme utilizes partial signal transmission, power amplifier and single point cross correlation. Correlation between input and output is determined by the use of this technique. Correlation values must lie between -1 and 1 and if not PAPR in transmitted signal is high otherwise it is low.

## VI. CONCLUSION AND FUTURE SCOPE

The proposed work provides in-depth study of OFDM along with problems caused due to sub carrier in OFDM. The PAPR is a disadvantage present within OFDM since spectral efficiency is reduced considerably. This presents problem for the analog to digital and digital to analog converters. PAPR hence has to be minimized. Techniques used for reduction in PAPR are discussed in brief. Partial signal transmission is least complex mechanism to reduce PAPR however weight factor is difficult to assign due to variation in signal stream. Selective mapping is also efficient enough for PAPR reduction. Both the techniques has certain limitations associated with them.

In future hybrid approach, combining partial and selective mapping scheme to reduce PAPR further can be worked upon.

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