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Mitigation the Issue of Peak to Average Power Ratio in OFDM Setups

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***Abstract*— The aim of this paper is to give the readers a correct education about the peak-to-average power ratio(PAPR) problem in orthogonal frequency division multiplexing(OFDM) systems. The growth in todays world in multimedia requires OFDM system as it can support higher data rates and high mobility. There are several techniques which are used to reduce PAPR like Selective Mapping(SLM).Clipping and Filtering, Partial Transmit Sequence(PTS) , companding and tone rejection. In this paper Clipping and Filtering and Selective Mapping(SLM) will be focused upon. Also the comparison of the results for the both will be done.**

Keywords—OFDM , PAPR, Filtering And Clipping , Selective Technique of Mapping(SLM), Partial Transmit Sequence (PTS)

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing(OFDM) is the best innovation that utilized in 4g remote correspondence frameworks, for example, Long haul Evolution (LTE), by and large interoproperbility for microwave find a good pace Long Term Evolution Advanced (LTE-An). OFDM are sorts of multicarrier transmission for broadband remote correspondence frameworks for example it has a huge data transmission around 20mhz. The foundation behind it is that the partitions the recurrence extend into subcarriers and the subcarriers are made commonly autonomously symmetrical to each other to maintain a strategic distance from obstruction. The data in each subcarriers is being transformed from series to parallel for simultaneous transmission .

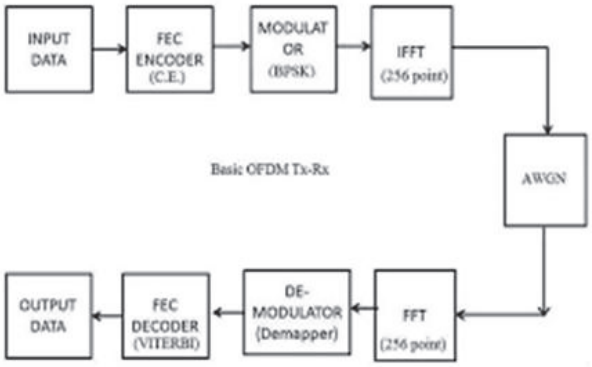

Fig. 1. OFDM System

A. Mathematical Formula For OFDM system

In OFDM systems, let N be the length of the block and vector X=[X_0 X_1…….X_{n-1}] and set of the X is T which shows single sub carrier set. As the N subcarriers transit signal we can also have $fn= n\Delta f$ and $n\Delta f = 1/NT$ where NT is duration of time of X block .

$$X(1)= \frac{1}{\sqrt{N}} \sum_{N=0}^{N-1} X_n \, e^{j2\pi\Delta f m} \; 0 \le m \le N \qquad (1)$$

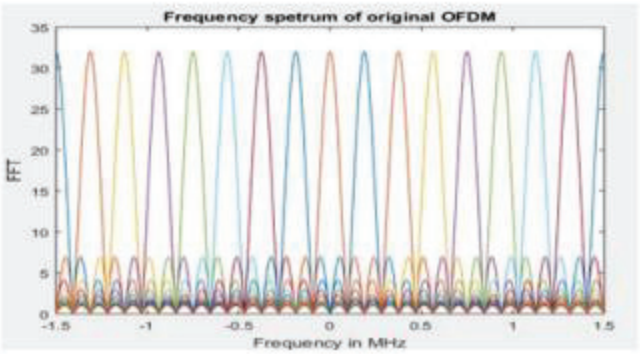

Fig. 2. Original OFDM frequency spectrum

The baseband of OFDM is defined by eq(2)

$$X(t)=\frac{1}{\sqrt{N}} \sum_{N=n/2}^{\frac{n}{2^{-1}}} (a_n + \frac{n}{2} \exp \frac{j2\pi nm}{T})s(t) \qquad (2)$$

Where the $n-th$ carrier is being modulated by complex symbol $a_n - \frac{n}{2}$, S9t0 is defined as the time function for (0,m) and let the amount of subcarriers is n OFDM symbol period is T.

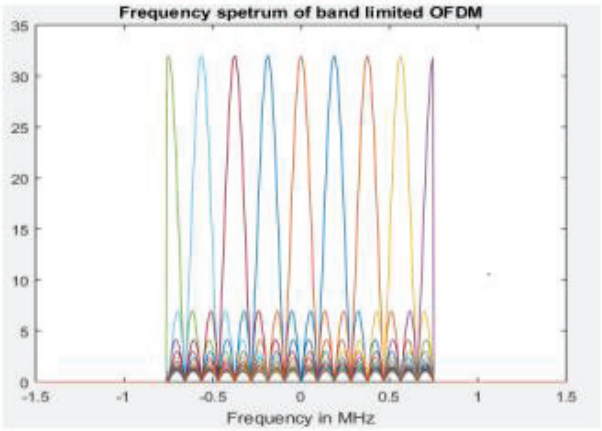

Fig. 3. Rate of occurrence for band limited

II. PEAK TO AVERAGE POWER RATIO (PAPR)

In the framework of OFDM, the primary downside is from top to lowest force proportion (PAPR).The high PAPR happens due to (IFFT) activity where the information images the subcarrier include and produce higher peak power values . This causes the signal enhancing and to work into the non linear distortion in band and radiations in out band. The in-band mutilation diminishes the nature of the framework exhibitions and out of band radiation causes the adjacent channel interface (ACI) because of neighbor band impact and reducing the performance of error bit rate(BER).

For continous time the PAPR for a signal is

$$\text{And } \frac{P_{Peak}}{P_{Average}} = \frac{\text{highest}|x(m)|^2}{V|x(m)|^2} \quad (3)$$

And $$\frac{\text{highest}|x(m)|^2}{V|x(m)|^2}$$

here peak value is denoted by P_{peak} ,average output power is denote by $P_{average}$. Expected value is denoted by V, Tx signal is denoted by X_n.It will increase if the number of subcarriers are also increased .The variance is σ_n^2 and the phase signal is uniform

$$F_{PAPR_{max}}(PAPR_0) = 1 - F_{PAPR_{max}}(PAPR_0)^n \quad (4)$$

Zero to maximum value is the range of threshold. Now, to calculate threshold the equation is (5)

$$\text{Threshold} = \left(\frac{PAPR_{max} - PAPR_{min}}{PAPR_{max}PAPR_{min}}\right) \quad (5)$$

The value of threshold is monitored constantly and the curve is drawn

$$\text{Efficiencny} = \left[\frac{(1 - PAPR_{db})}{PAPR_{db}}\right] \text{ x } 100 \quad (6)$$

The percentage of reducing the peak power is determined by equation (6)

III. REDUCTION TECHNIQUE

A few procedures are utilized and proposed to lessen PAPR issue in various classifications consequently bending and without mutilation. the strategy incorporates cutting and separating ,particular mapping, halfway transmit grouping ,tone infusion and so forth. Be that as it may, here we for the most part will concentrate on two most significant procedures talked and utilized that is slm and clipping for peak to average decrease ODFM frameworks.

IV. FILTERING AND CLIPPING

Filtering and Clipping is one the most easiest technique for reduction of PAPR. Clipping the amplitude decreases the pinnacle level of the sign to a pre-determined value[1].Basically the high peak parts of the signal outside the desired region are clipped which is know as amplitude clipping. This phenomena start from the transmitter itself and the receiver signal is dependent on the clipped signal . The parameters like the area and size of the cut-out sign at unit cutting per OFDM is calculated by the receiver. In band and out band distortion radiation into the OFDM system leads to peak re growth importantly in non-linear system all this happens because of clip. Also this effects the error bit rate activity and the signal noise ratio increases. At a certain level the clipping is done also the pinnacle power decreases and out band distortion is decreased after filtering is done .

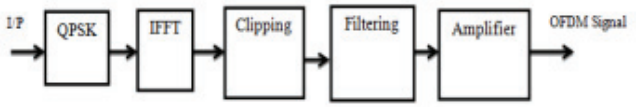

Fig. 4. Filtering And Clipping

Amplitude clipping is shown by the equation(7)

$$Y(t) = \begin{cases} -L & if\ x(t) < -L \\ x(t) & if\ -L \le x(t) \le L \\ L & if\ x(t) > L \end{cases} \quad (7)$$

Where passband clipped signal is Y(t) ,clipping level is L and passband signal is X(t).

TABLE I. PARAMETERS USED FOR FILTERING AND CLIPPING

Parameters	Value
Modulation	QAM
Channel Modes	Additive white Gaussian noise
Fast Fourier Transform	255
Sub-Carriers	201
Level of clipping	0.78
Phase rotation	7

V. SELECTIVE TECHNIQUE MAPPING (SLM) :

Proposed strategy to decrease the top to average transmission intensity multi carrier balance frameworks with mapping[7] . In mapping (SLM) the entire arrangement of data image are stacked into the subcarrier and afterward transformed into sequential and parallel after, the information square are framed and afterward the most positive sign with least PAPR is picked and transmission is done around then. The essential thought of the strategy depends on the stage turn arrangement. The least PAPR signal will be chosen for transmission from various information squares freely.

If each data block is considered then

$$B(U) = [b_u, b_{u,1} \dots \dots \dots b_{u,N-1}]^T$$

multiplied by u phases of N length. The data block modified for u^{th} phase sequence

$$= [P_0 b_{u,0} P_1 b_{u,1} \dots \dots \dots P_{N-1} b_{u,N-1}]^T$$

In this [u = 1,……u].Most least one is first chosen and then transmitted .

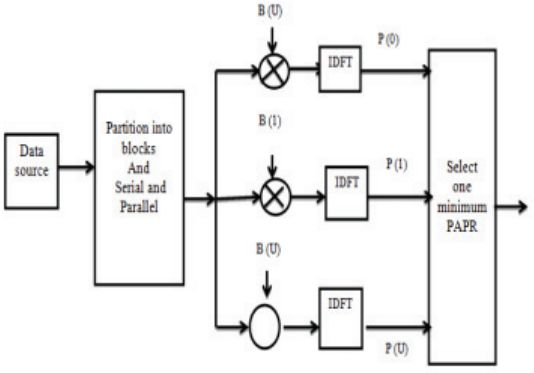

Fig. 5. Selective Mapping Block Diagram

Now PAPR will be expressed as

$$(\text{PAPR} > P_0 = 1 - (1 - e^{-p_o})^n$$

TABLE II. SLM PARAMETERS USED

Parameter	Value
Modulation	QAM
Channel Modes	Additive white Gaussian noise
Sub-Carrier	255
Phase Sequence	7

Parameters of table (2) are applied in equation(7) to find out the degradation in amplitude peak power and the threshold value is found out using equation (5) also in this the lowest PAPR is experienced.

VI. SIMULATION RESULTS

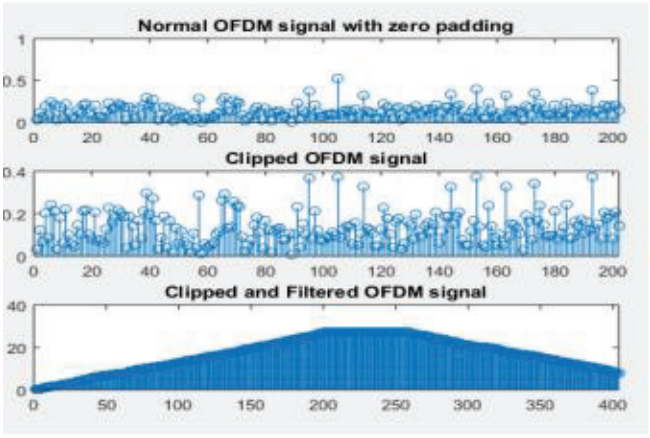

Fig. 6. Results Of Filtering And Clipping

In the figure the peak power is within .5 before applying filtering and clipping with normal PAPR 7.3 . After clipping the amplitude of peak is reduced to .4 having different level of amplitude but there is still peak regrowth and distortion .After filtering the level of peak power is decreased upto 2.4 and there is a increase in sampling with no distortion .

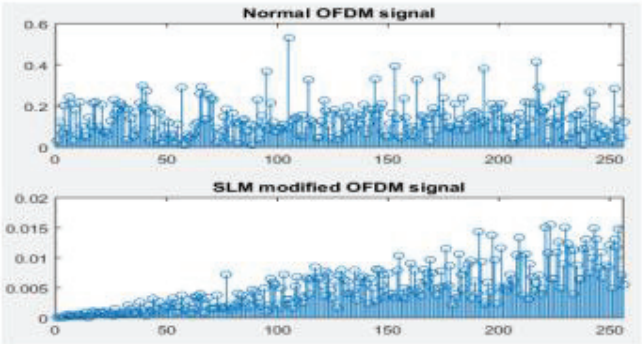

Fig. 7. Selective Mapping results

It is applying that when selective mapping the peak level is most that is .6 with 22.8 as original PAPR .

After applying the peak power reduces to .02 approx and also low PAPR is experienced .

VII. COMPARISON BETWEEN SLEECTIVE MAPPING WITH FILTERING AND CLIPPING

The productivity of cutting is 61.9% and that of particular mapping is 21.9% .So the conclusion is that filtering and cutting gives more decrease in PAPR than specific mapping around 39.9%.

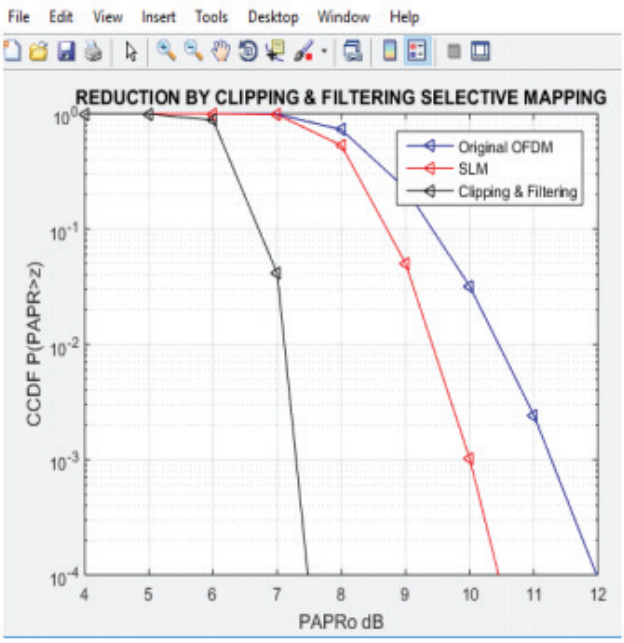

Fig. 8. Comparison using CCDF graph

TABLE III. COMPARISON BETWEEN BOTH

Reducing Techniques	Framework			Operation requirement at TX and RX
	Decrease distortion	Power raise	Defeat Data rate	
Clip and filter	Nil	Nil	Nil	Tx:extract Rx:NIL
Selective Mapping	yes	Nil	yes	TX:timers IDFT operations RX:Side information

VIII. CONCLUSION

In the paper we recreate the framework with filtering and clipping . Both the strategies diminishes peak adequacy level which prompts increment examining number, information rates, better otherworldly effectiveness and great execution of Bit mistake rate (BER). Two distinctive regulation systems,. Likewise clipping and filtering, and specific mapping are the simplest and quickest additionally possible strategies to decrease PAPR

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