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Optimization of PAPR Using HPA and Amplitude Clipping Reduction Technique

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ABSTRACT: In modern age, the service users of every network desire faster downloading speed/data rates so that they can watch live cricket, live video conferencing, IRCTC Ticket Booking etc. A technique known as OFDM is used to achieve faster speed. Orthogonal Frequency Division Multiplexing (OFDM) has been more popular for broadband wireless transmission due to its robustness against multipath fading. In OFDM system, orthogonally sub-carrier are used to carry the data from the transmitter end to the receiver end with the presence of guard band. OFDM gives us benefits like high spectral efficiency, resiliency of RF interference and lower multi-path distortion. But OFDM has disadvantage in form of high PAPR (Peak to average power Ratio) and thus, when OFDM signal pass through power amplifier system the signal distort [2]. So a need of technique which reduces PAPR and amplitude clipping is one of the techniques used to reduce PAPR .In amplitude clipping, a threshold value of the amplitude set and any subcarrier having the amplitude more than that value is clipped or that subcarrier is filtered to bring out a lower PAPR values.

KEYWORDS: BPSK, OFDM, PAPR, IFFT, HPA, BER

I. INTRODUCTION

The growing technology of wireless communication has created a strong demand for advance wireless technique. They are producing some challenge for wireless communication design come from the detrimental characteristics of wireless environments, such as Doppler effect, ISI interference and multipath fading[5] .At this time every persons wish to have high speed of wireless communication. There are various multiplexing technique used to increase high speed wireless communication .The name of some technique used in high speed wireless communication are code division multiplexing access(CDMA) and orthogonal frequency division multiplexing(OFDM).OFDM is a one type of multicarrier multiplexing access technique which are used for transmitting large data over wireless channel in the 4G system where minimum data rate required to be 10-20 mbps & at least 2 mbps in moving vehicles and modulating technique adopted by 4G mobile system is OFDM[3].The first OFDM scheme dates block published by Robert W. Chang his pioneering work on the synthesis of band-limited orthogonal signal for multi-channel data transmission[4] .In OFDM a large number of orthogonal, overlapping, narrow band sub carrier are transmitted in parallel, which is used in digital communication, a method for digital audio broadcasting(DAB) and terrestrial digital video broadcasting(DVT-T) in the Europe. But there is one drawback of OFDM signal that Its Peak-To-Average Power Ratio (PAPR) high due to that power amplifier saturates so that the message signal distorts. There are many technique used to reduce high PAPR. These techniques are SLM technique, Selective mapping with phase rotation and Amplitude clipping, Partial Transmit sequence but in this paper I use Amplitude clipping with HPA as a PAPR reduction technique. Amplitude clipping and filtering is most effective technique. But amplitude clipping and filter technique is a nonlinear process which produce more distortion in band of frequency, increase BER and also decrease spectral efficiency. At last I can say that, this technique will reduce PAPR without spectrum expansion.

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II. RELATED WORKS

In [2] authors tell about Orthogonal Frequency Division Multiplexing (OFDM) has been currently field of research in broadband wireless transmission due to its robustness against multipath fading. But OFDM signals have a problem of high Peak-to- Average power ratio (PAPR) and thus, a power amplifier must be carefully manufactured to have a linear input-output characteristic or to have a large input power back-off. Authors also tell, some of the important PAPR reduction techniques. In [3] authors say OFDM is well known Technique for transmitting large data Over limited frequency band. Its main disadvantage is PAPR (Peak to average power ratio) nothing but several sinusoidal leads. In this authors tell about various PAPR Reduction techniques. This technique can be used according to their performance. In [6] authors tell that as the technology grows in wireless communication, the concept of multicarrier modulation come into picture OFDM prove itself invaluable for multicarrier modulation. OFDM subcarriers can overlap to make full use of the spectrum but at the peak of each subcarrier, the power in all the other subcarriers is zero. Also tell about the major disadvantages of OFDM signal is large PAPR, which require power amplifier with large linear (gain) ranges. But to increase efficiency of power amplifier it gain become nonlinear and corresponding OFDM signal distort. So, a need for technique which reduces PAPR. Selective Mapping with phase rotation is one of the techniques to reduce PAPR .Also Authors compare the effect of different modulation (QPSK, DQPSK, and 4-QAM) on PAPR value of OFDM signal and its reduction by using selective mapping phase rotation method. In [8] authors also tell about OFDM & Its disadvantage. In his research also propose how to reduce these disadvantages. The SLM technique provides good performance for PAPR reduction, but it requires an inverse fast Fourier transforms (IFFTs) to generate a set of orthogonally sub carriers. In this paper, authors propose a kind of low-complexity conversions to replace the IFFT blocks in the conventional SLM method. In [9] authors tell about Orthogonal Frequency Division Multiplexing (OFDM) technology is undoubtedly the best available option for supporting high data rate in both wired and wireless communication systems. But, the feature of high peak-to-average power ratio (PAPR) restricts its usage in some applications. So propose a technique to reduce this PAPR. The technique named a Nonlinear Companding Transform (NCT) technique. Also plot a graph between peak-to-average power ratio (PAPR) of SC PAPR reduction and bit error rate (BER) performances. The simulation results show better performance of the proposed scheme as compared to competitive alternatives. In [10] authors tell about Orthogonal frequency division multiplexing (OFDM) is an attractive technique for wireless communication applications. However, an OFDM signal has a large peak-to-mean envelope power ratio, which can result in significant distortion in OFDM signal when passed through a nonlinear device, such as a transmitter power amplifier. They investigate, through extensive computer simulations, the effects of clipping and filtering on the performance of OFDM, including the power spectral density, the crest factor, and the bit-error rate. The results show that clipping and filtering is a promising technique for the transmission of OFDM signals using realistic linear amplifiers.

III. OFDM PRINCIPLE

The basic principle of OFDM is high speed form of multi-carrier modulation which is particularly suited for transmission over a dispersive channel. Here the different transmitting signal are orthogonal to each other[1]. OFDM is a combination of modulation & multiplexing technique. It is more advance approach than conventional multiplexing approach .OFDM system also has frequency offset due to the Doppler shift in the channel [7]. There are some applications of OFDM in digital television and audio broadcasting, DSL broadband internet access, wireless networks & 4G mobile communication. OFDM having more advantage over single carrier modulation is that its ability to cope with severs channel condition without complex equalization filter [8].

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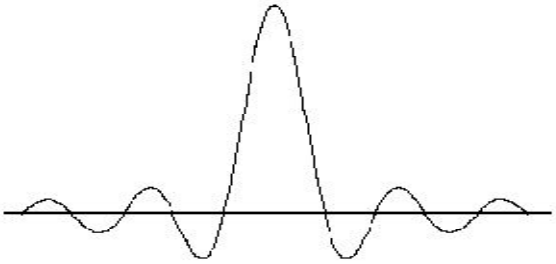

Fig.1 Spectrum of an OFDM Sub-channel

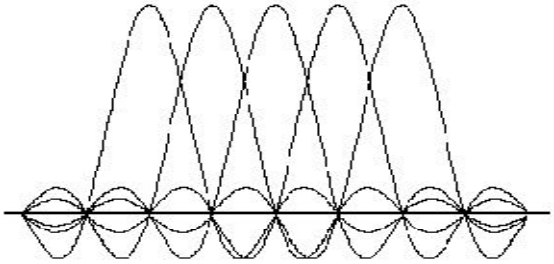

Fig.2 OFDM Spectrum (During a signal bit)

IV. SYSTEM MODEL

Assume that the data (bit) stream is generated by using random integer generator block of MATLAB/SIMULINK. The data value are modulated by using BPSK modulation. The length of the data block M is denoted by as a vector = [Y0 , Y1 , Y2 , Y3 , Y4 , Y5 , ----------YM-1]T where M is equal to the number of sub-carriers. The complex envelope of the transmitted OFDM signal is given by

$$Y(t) = \frac{1}{\sqrt{M}} \sum_{M=0}^{M=1} y_m \, e^{j2\pi f t f_m}, \; 0 \le t < MT \quad \text{---------- (1)}$$

Now the peak to average power ratio is calculated by using the formula

$$\text{PAPR} = \frac{\text{Ppeak}}{\text{Paverage}} = \frac{0 \le t < MT \, |Y(t)|^2}{\frac{1}{MT} \int_0^{MT} |Y(t)|^2} \quad \text{---------- (2)}$$

OFDM have a disadvantage of high PAPR [9]. The Peak-To-Average-Power Ratio is also define by ratio of peak amplitude square (given peak power) and rms value square (given the average power)

$$\text{PAPR} = \frac{PEAK\ POWER}{AVERAGE\ POWER} = |X|\text{peak2/xrms2}$$

V. CLIPPING AS PAPR REDUCTION

Amplitude clipping technique is a simplest technique which can use for PAPR reduction. A threshold value of the amplitude is set in this case to limit the peak envelop of the input signal. But here signal having values higher than this predefined value are clipped and rest is allowed to pass through un-disturbed channel [1].

$$u(y) = \begin{cases} y & |y| \le A \\ A\, e^{j\emptyset(y)} & |y| > A \end{cases}$$

Where u(y) = Amplitude clipping value after clipping.

y = Initial signal value.

A = Threshold set by the user for clipping the signal.

During amplitude clipping distortion is observed in the system which can be viewed as another source of the noise. This distortion falls in both in-band and out-of band. Filtering technique can not be the implemented to reduce the in-band distortion and error performance degradation is observed here [5]. On the other hand spectral efficiency is hampered by out-

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of-band radiation. Out-of-band radiation can be reduced using filtering technique after clipping process but this may result in some peak re-growth. This problem can be solve by implementing repeated filtering and clipping operation after that the desired amplitude level is achieved [7].

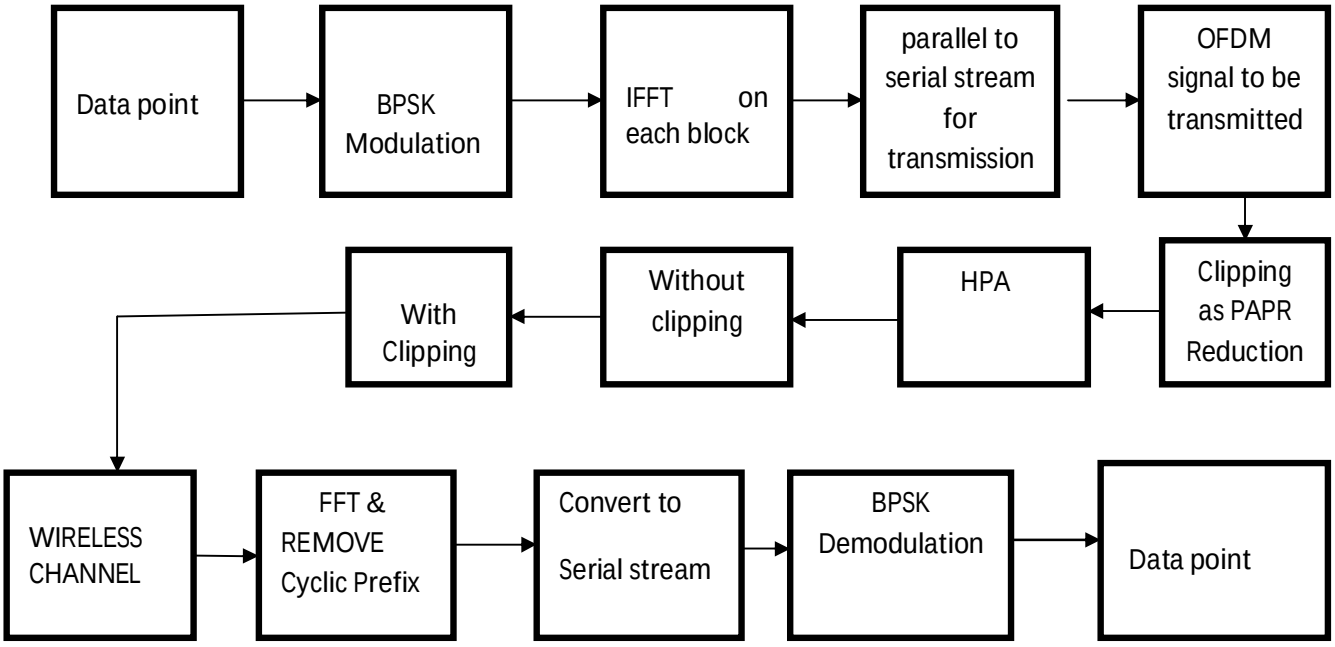

Figure.3 OFDM Transmitter & Receiver

VI. SYSTEM PARAMETER

No. of Sub-Carriers	:256
IFFT Size	: 64
Modulation	: BPSK
Constellation mapping	: 2
Average Thresold Value	: 0.4

VII. SIMULATION RESULT

All the simulation will be performed in MATLAB 7.8. We calculate the PAPR without amplitude clipping technique BPSK modulation the PAPR is found to be 0.76dB as shown in figure 5.but when PAPR reduction with amplitude clipping for the same modulation is used the PAPR value found to be 0.40dB as shown in figure 4. So, the value reduced by factor 0.36dB .Also when we calculate the PAPR of basic OFDM system using HPA (high power amplifier) method the value come out to be 1.5dB as shown in figure 6.but when we apply the amplitude clipping technique to OFDM technique after HPA the reduced PAPR value come out to be 0.40dB shown in figure 7. So value reduced by 1.10dB. From table 1 shown below more PAPR value is reduced with HPA after amplitude clipping & its come out to be 1.10 dB.

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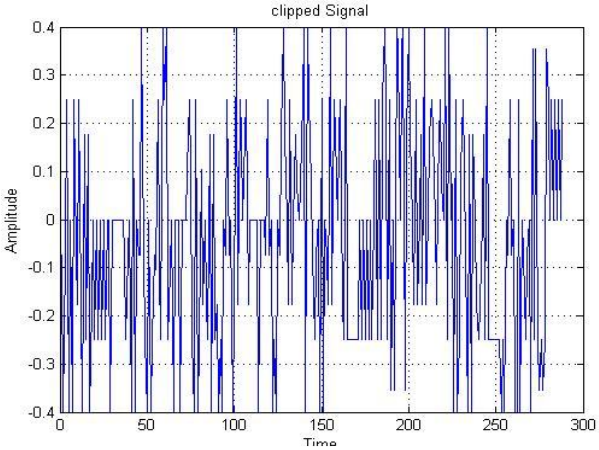


Fig.4 OFDM signal after clipping

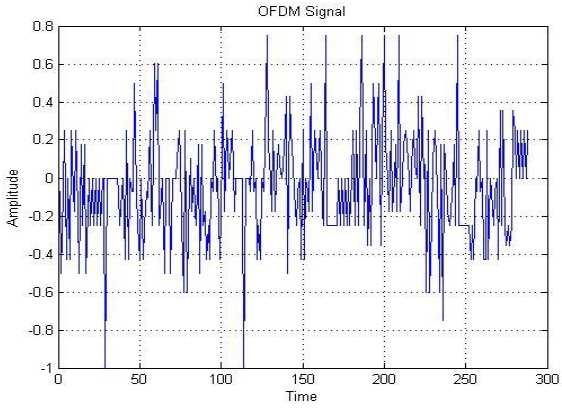
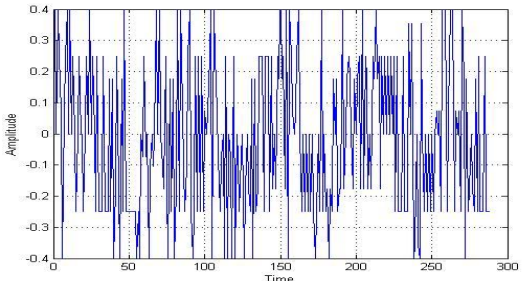


Fig.5 OFDM signal to be transmitted



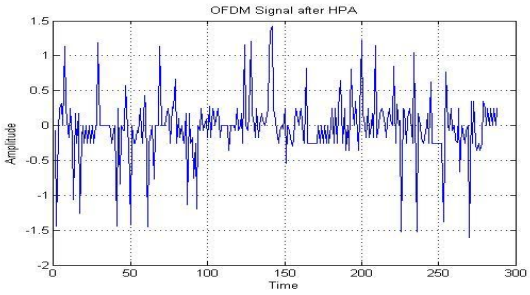


Fig.7 With Clipped OFDM signal after HPA

Table 1: Show the PAPR value with & without Amplitude Clipping Technique

Comparison of PAPR(dB) with & without amplitude clipping	BPSK	HPA
Without Amplitude clipping	0.760	1.50
With Amplitude clipping	0.40	0.40
Difference in PAPR(dB) with & without Amplitude clipping	0.360	1.10

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VII. CONCLUSION & FUTURE WORK

Reducing PAPR of OFDM signal is Very Important for increasing the performance of communication equipment like RF Transmitter, DTH etc. So in this paper I use BPSK modulation, high pass Amplifier (HPA) on the OFDM signal and use of Amplitude Clipping Technique to obtain least PAPR of OFDM signal. Amplitude Clipping Technique is very simple and achieves significant reduction in PAPR. In this paper I have taken 256 subcarriers, as the no of subcarriers increase then analyze the significant change in PAPR value by using Amplitude Clipping as PAPR reduction Technique.

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BIOGRAPHY

Ritesh Baranwal is presently working as a Faculty in Department of Electronics and Instrumentation Engg., VBS Purvanchal University, Jaunpur, India He has completed M.Tech (Communication System) in 2012 & achieves Silver Medal. His area of Interest in Wireless Communication.