PERFORMANCE ANALYSIS OF OFDM BY USING DIFFERENT CLIPPING TECHNIQUES

Anita.R.Jadhav[1], A.N. Jadhav[2]

[1]*D.Y.Patil College Of Engg And Technology, Kolhapur, Maharashtra (India)*

[2] *Prof. D.Y. Patil College Of Engg And Technology, Kolhapur, Maharashtra (India)*

ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) has become the popular modulation technique in high speed wireless communications. One of the main disadvantages of Orthogonal Frequency Division multiplexing (OFDM) is its high Peak-to-Average Power Ratio (PAPR), which significantly reduces the efficiency of the High Power Amplifier (HPA). Due to the simplest way for PAPR reduction, clipping techniques are frequently used in practice for OFDM PAPR reduction. In this paper, Classical-Clipping (CC), Deep-Clipping (DC) and Smooth-Clipping (SC) are implemented for reducing the PAPR of an OFDM system. The effectiveness of these techniques in terms of PAPR-reduction average power variation and total system degradation are evaluated.

Keywords: **- Orthogonal Frequency Division Multiplexing (OFDM), Peak-To-Average Power Ratio (PAPR), Clipping Techniques.**

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is currently attracting more attention in wireless communications to meet the ever-increasing demands arising from the explosive growth of internet, multimedia, and broadband services. Orthogonal Frequency Division Multiplexing (OFDM) is a Multi-Carrier Modulation technique in which a single high rate data-stream is divided into multiple low rate data-streams and is modulated using subcarriers which are orthogonal to each other [2].OFDM is a "Multi-Carrier Transmission Scheme. "ODFM is a good solution for high speed digital communications. In this the data to be transmitted is spreader over a large number of orthogonal carriers, each being modulated at a low rate[3].The carriers can be made orthogonal by appropriately choosing the frequency spacing between them[1]. One benefit of OFDM in a wireless communications system is that the receiver does not need to constantly adapt an equalizer as a single carrier system would. OFDM system shows much favorable properties such as high spectral efficiency, robustness to channel fading, immunity to impulse interference, capability of handling very strong echoes (multipath fading). In OFMD signals consists of number of independent modulated sub-carriers in an OFDM system which can give a large peak-to average power ratio (PAPR) when added up coherently. Due to Presence of large number of independently modulated sub-carriers in an OFDM system the peak value of OFDM system can be very high as compared to the average of the whole system. One of the simplest way to reduce the PAPR is to use clipping and filtering technique, The clipping techniques like classical clipping (CC), Deep clipping (DC), smooth clipping (SC) etc. Clipping introduces two major undesirable nonlinear effects like out of band radiation and in band distortion.

II. SYSTEM DESCRIPTION

The basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers. These subcarriers are overlapped with each other. Because the symbol duration increases for lower rate parallel subcarriers, the relative amount of dispersion in time caused by multipath delay spread is decreased. Inter-symbol interference (ISI) is eliminated almost completely by introducing a guard time in every OFDM symbol.

An ofdm system consists of N subcarriers. the OFDM symbolx(t), 0 <t< T, consists of N complex baseband data x0,x1,….Xn-1 carried on N subcarriers, choosen to be orthogonal with constant spacing Δf.

The OFDM symbol x(t)

$$x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi\Delta f t}, 0 \le t \le T \qquad (1)$$

III. PEAK-TO-AVERAGE POWER RATIO (PAPR)

High Peak-to-Average Power Ratio has been recognized as one of the major practical problem involving OFDM modulation. High PAPR occur when signal is converted into time domain through IFFT the resulting signal is sum of n number of subcarrier and the peak of resulted signal becomes n times higher than normal averaged signal[2]. Power amplifier becomes saturate when this large signal peak is given to it. Thus, causing intermediation distortion in the transmitted signal. Intermediation distortion can be reduced by Operating power amplifier at the transmitter in linear range. Such power reduction or power back off results in inefficient operation of the OFDM system [4]. In the case of OFDM, these carriers are orthogonal and with constant inter carrier spacing $\Delta f = 1/T$, where T is the OFDM symbol duration. The complex baseband representation of multicarrier signal consisting of K subcarriers is given

$$x(t) = \sum_{n=0}^{N-1} X_k e^{j2\pi f_k t},$$

$$0 \le t \le NT$$

The PAPR is defined as the ratio between the maximam power and the average power,

$$PAPR = \frac{\max|x(t)|^2}{E\left[|x(t)|^2\right]}$$

where$E$[.] denotes the expectation operator.

Since the signal is generated digitally, the PAPR can be computed using discrete-time values $xl = x(lTs)$, $l = 0, 1….Ns$.To accurately account for all the amplitude values, it is necessary to oversample the signal. Reducing

the *max|x(t)|* is the principle goal of PAR Preduction techniques. Since, discrete- time signals are dealtwith in most systems, many PAPR techniques are implemented to deal with amplitudes of various samples of *x(t)*. Due to symbol spaced output in the first equation we find some of the peaks missing which can be compensated by oversampling the equation by some factor to give the true PAPR value.

IV. WHY TO REDUCE PAPR?

(i) A major obstacle is that the OFDM signal exhibits a very high Peak to Average Power Ratio (PAPR).
(ii) Therefore, RF power amplifiers should be operated in a very large linear region. Otherwise, the signal peaks get into non-linear region of the power amplifier causing signal distortion. This signal distortion introduces intermediation among the subcarriers and out of band radiation. Thus, the power amplifiers should be operated with large power back-offs. On the other hand, this leads to very inefficient amplification and expensive transmitters. Thus, it is highly desirable to reduce the PAPR.
(iii) These large peaks cause saturation in power amplifiers, leading to intermediation products among the subcarriers and disturbing out of band energy. Therefore, it is desirable to reduce the PAPR.

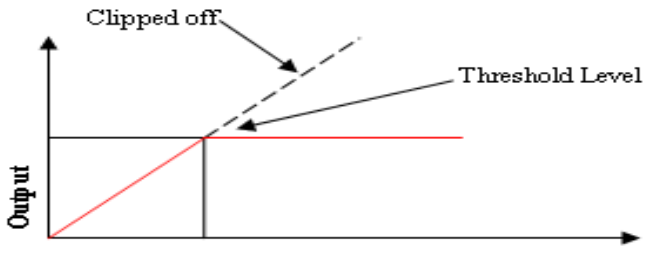

Figure 2. Clipping Method

In this paper, we will mainly focus on clipping method of PAPR reduction. One important feature of the peak-to-average ratio in the OFDM is the fact that the percentage of symbols has a very large peak-power is less and the percentage decreases with an increase in the number of sub-carriers. Thus in this case, the simplest possible solution to the peak-power problem would be clipping, i.e., limiting the peak amplitude to some maximum level. Although simple, this method has a few disadvantages. Clipping produces a kind of self-interference that causes some degradation in the BER performance. The non-linear distortion caused due to clipping increases the amount of out-of-band radiation. If clipping threshold (A) is chosen to a large value, then fewer samples are clipped and it decreases the probability of clipping (called CCDF).

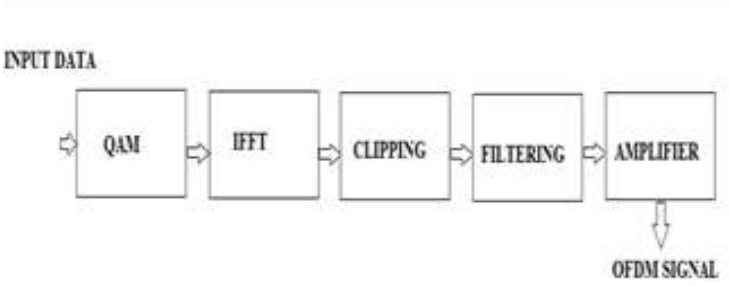

Fig.3 The OFDM Transmitter Including Clipping Schemes.

The block diagram which is used for OFDM system is shown in fig.the modulation technique is choosen as QAM.

V. PAPR REDUCTION TECHNIQUES

One of the simplest way to reduce the PAPR is to use clipping and filtering technique, The clipping techniques like classical clipping (CC), Deep clipping (DC), smooth clipping (SC) etc. Clipping introduces two major undesirable nonlinear effects like out of band radiation and in band distortion. The out of band radiation results in unacceptable interference to user in neighboring RF channels.

5.1 Classical Clipping

The Classical Clipping (CC) proposed in [6] is one of the most popular clipping technique for PAPR reduction knownin the literature [11, 12]. It is sometimes called hard clippingor soft clipping, to avoid any onfusion, it is called ClassicalClipping (CC) in this paper. In [6], its effects on the performance of OFDM, including the power spectral density,the PAPR, and BER is evaluated. In this paper, in additional of PAPR and BER, its average power variation is computed.

$f(r) = r, r \leq A$

$A, r > A$, where A is the clipping level.

5.2 Deep Clipping

It should know that, Deep Clipping (DC) has been proposedin [7] to solve the peaks regrowth problem due to the out-ofbandfiltering. So, in DC technique, the clipping function ismodified in order to “deeply” clip the high a amplitude peaks.A parameter called clipping depth factor has been introducedin order to control the depth of the clipping.

$$f(r) = \begin{cases} r, & r \leq A \\ A - \alpha(r - A), & A < r \leq (1+\alpha/\alpha)A \\ 0, & r > (1+\alpha/\alpha)A \end{cases}$$

,

Where α is the clipping depth factor

5.3 Smooth Clipping

In [8] a Smooth Clipping technique is used to reduce theOFDM PAPR. In this paper, the function based-clipping for

SC technique is defined below.

f (r) = r – 1/b r3, r≤ 3/2A

A, r>3/2A , where b =27/4,A2.

VI. PERFORMANCE SIMULATIO

The waveform of ofdm signal before clipping is plotted in fig.theofdm system used in the simulation consist of 64 QAM modulated data points.

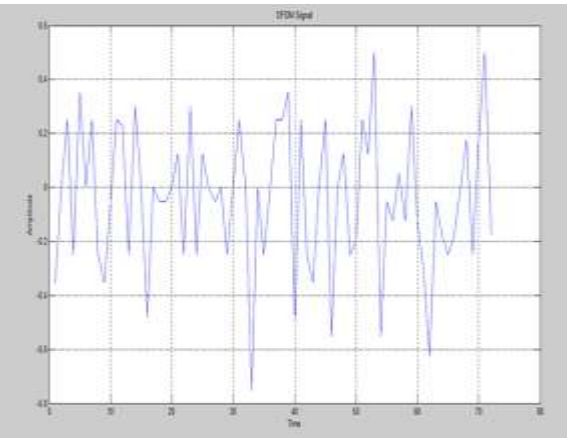

Fig.1. OFDM Signal

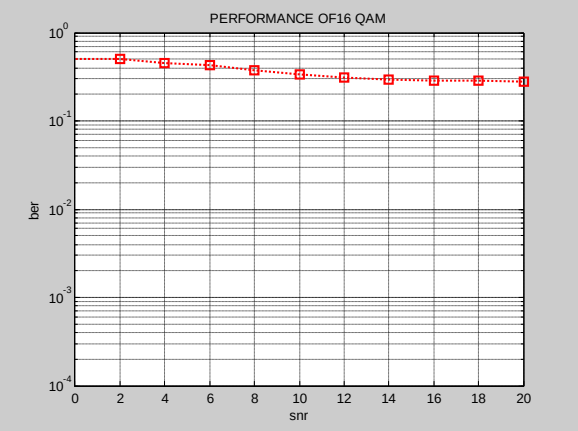

Fig.2. BER Performance Of CC Technique

Parameters used to check the performance are bit error rate (BER), signal to noise ratio (SNR) are discussed below. The simulation results of The BER vs. SNR are plotted in Fig.1.

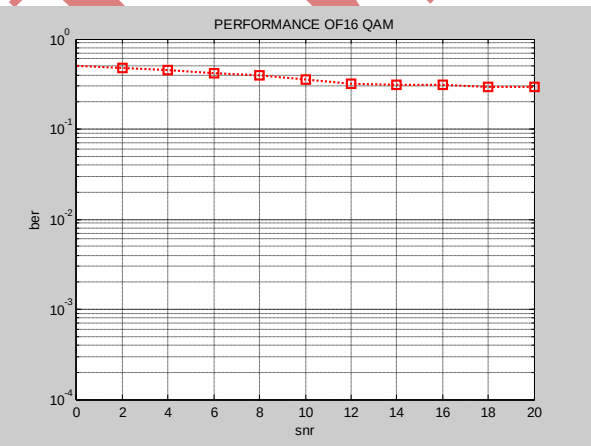

Fig.3BER Performance Of Deep Technique.

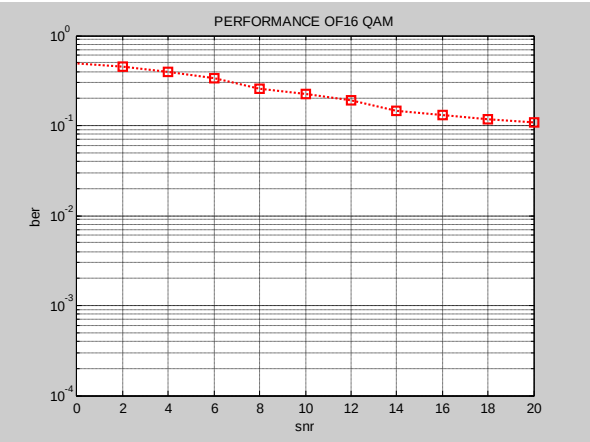

Fig.4 BER Performance Of Smooth Technique.

VII. CONCLUSION

OFDM is a very attractive technique for wireless communications due to its spectrum efficiency and channel robustness. One of the serious drawbacks of in OFDM systems is that the composite transmit signal can exhibit a very high PAPR when the input sequences are highly correlated.

In this paper, the performance of three clipping techniques. In terms of PAPR reduction, BER degradation are evaluated**.** We describe the CC,DC, SC clipping technique for PAPR reduction. also it is observed that QAM Modulation technique to see BER performance. As BER is decreased automatically PAPR of the OFDM signal will reduce.

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