Clipping techniques for PAPR reduction in OFDM system

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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.

INDEX TERMS— Orthogonal Frequency Division Multiplexing (OFDM), Peak-to-Average Power Ratio (PAPR), clipping techniques.

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I. INTRODUCTION

Orthogonal Frequency DivisionMultiplexing (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 spreaded 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 $x_0, x_1,....X_{n-1}$ carried on N subcarriers, choosen to be orthogonal with constant spacing Δf.

The OFDM symbol x(t)

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

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 intermodulation distortion in the transmitted signal. Intermodulation 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 amulticarrier 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,

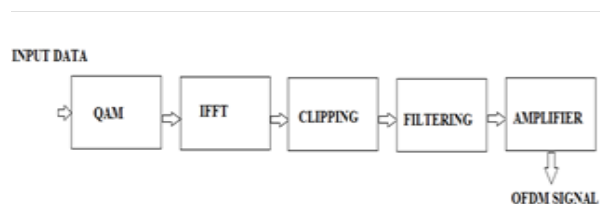$$PAPR = \frac{\max|x(t)|^2}{E\left[|x(t)|^2\right]}$$

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.

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

2.Deep clipping:

It should know that, Deep Clipping (DC) has been proposed in [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) =   r   ,   r ≤ A
         A − α (r − A)   ,   A < r ≤ (1+α/α)A ,
              0   ,   r>(1+α/α)A ,

Where α is the clipping depth factor

3.Smooth clipping:

In [8] a Smooth Clipping technique is used to reduce the OFDM 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.

VII PERFORMANCE SIMULATION

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

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.
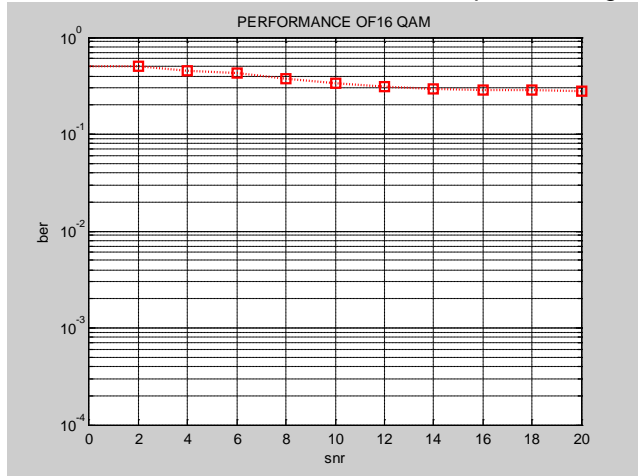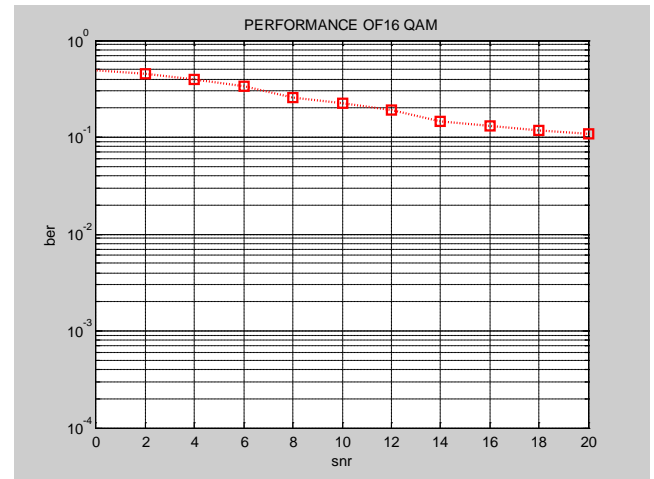

Fig.2.BER performance of CC technique.
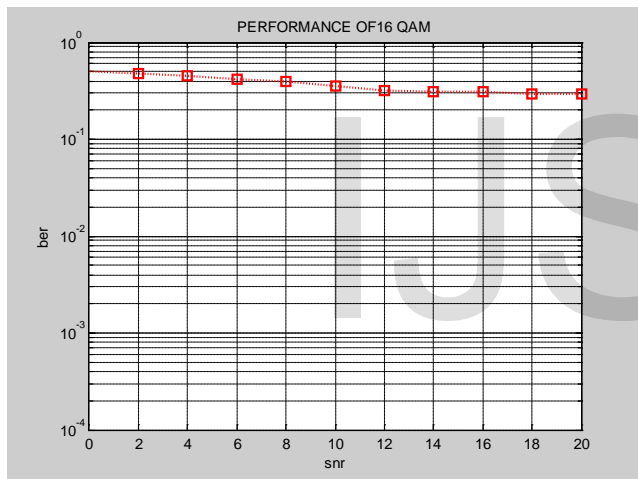

Fig.4 BER performance of smooth technique.

Fig.3BER performance of deep 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.

VIII. REFERENCES

[1] A. R. S. Bahai and B. R. Saltzberg, "Multi-Carrier Digital Communications: Theory and Applications of OFDM," Kluwer Academic/ Plenum   Publishers, New York, NY, USA, 1999.

[2].T. Jiang and Y. Wu, "An Overview: Peak-to-Average Power Ratio Reduction   Techniques for OFDM Signals", IEEE Trans. on Wireless Communications,pp. : 56- 65, June 2008

[3].] H.G. Ryu "Combination of PAPR reduction and linearization for the OFDM communication system," Wireless Commun.and Mobile Computing, pp.46-52,Vol.54,No.2, Feb.2010

[4] D. Guel, J. Palicot , "Clipping formulated as an adding signal technique for OFDM Peak Power Reduction", IEEE, 2009.

[5] H. Ochiai, H. Imai, "Peak power reduction schemes on OFDM systems: a review", Proc. Wireless Personal Multimedia cmmunications Symposium   (WPMC) 98, Japan, pp. 247-252.

[6] X. Li and L.J. Cimini, "Effects of Clipping and Filtering on the Performance   of OFDM," IEEE Communication Letters, vol. 2, no. 5, pp.   131-133, May 1998.

[7] S. Kimura, T. Nakamura, M. Saito and M. Okada, "PAR reductionfor OFDM signals based on deep Clipping", 3rd International Symposiumon communications, Control and Signal Processing, pp. 911 - 916,March 2008.

[8] P. Boonsrimuang, E. Puttawong, H. Kobayashi and T. Paungma, "PAPRReduction Using Smooth Clipping in OFDM System", The 3rd Informationand Computer Engineering Postgraduate Workshop 2003 (ICEP'2003), pp. 158-161, Jan 2003.

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