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RESEARCH ARTICLE

Study on PAPR Reduction on Spectrum and Energy Efficiencies in Orthogonal Frequency Division Multiplexing with Low Complexity

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ABSTRACT- Orthogonal Frequency Division Multiplexing (OFDM) faces the Peak-to-Average Power Ratio (PAPR) problem that is a main disadvantage in multicarrier transmission system. Here in this paper an attempt is made to improve the spectrum efficiency (SE), and energy efficiency (EE) in orthogonal frequency division multiplexing (OFDM) systems, Simulation results show that the OFDM system with PAPR reduction could achieve higher SE and EE than that of the system without PAPR reduction with CCDF.

Index Terms—"Orthogonal Frequency Division Multiplexing (OFDM), Peak-to-Average Power Ratio (PAPR), High Power Amplifier (HPA), Energy Efficiency (EE), Spectrum Efficiency (SE)"

I. INTRODUCTION

The Orthogonal Frequency Division Multiplexing (OFDM) possesses several desirable attributes, such as immunity to the inter-symbol interference, robustness with respect to multi-path fading, and ability for high data rates. Thus OFDM has been proposed in various wireless communication standards such as IEEE802.11a standard for wireless Local Area Networks (WLAN), IEEE802.16a standard for Wireless Metropolitan Area Networks (WMAN), [1]. However, one of the major drawbacks of OFDM system has been its high Peak-to-Average Power Ratio (PAPR). PAPR reduction techniques can be employed such that the linear range of HPA can be reduced. The SE performance of OFDM systems has been well investigated by various researches [2, 3, 4], and the EE performance has also been studied with the different technique and does not reduce the PAPR problem [5,6]. The partial transmit sequence (PTS) scheme is used as an example for the analysis, because it can significantly reduce the PAPR of OFDM signals without any signal distortion [7, 8]. Besides, the PTS scheme does not waste the spectrum since the side information can be eliminated by the methods proposed in [9, 10, 11].

II. PAPR IN OFDM

OFDM is developed due to the necessity of high data rate so that many users can work at a time. The word 'ORTHOGONAL' point to the mathematical relation among the frequency of subcarrier. This system is used to reduce the frequency space between the carriers to minimize the bandwidth on channel.

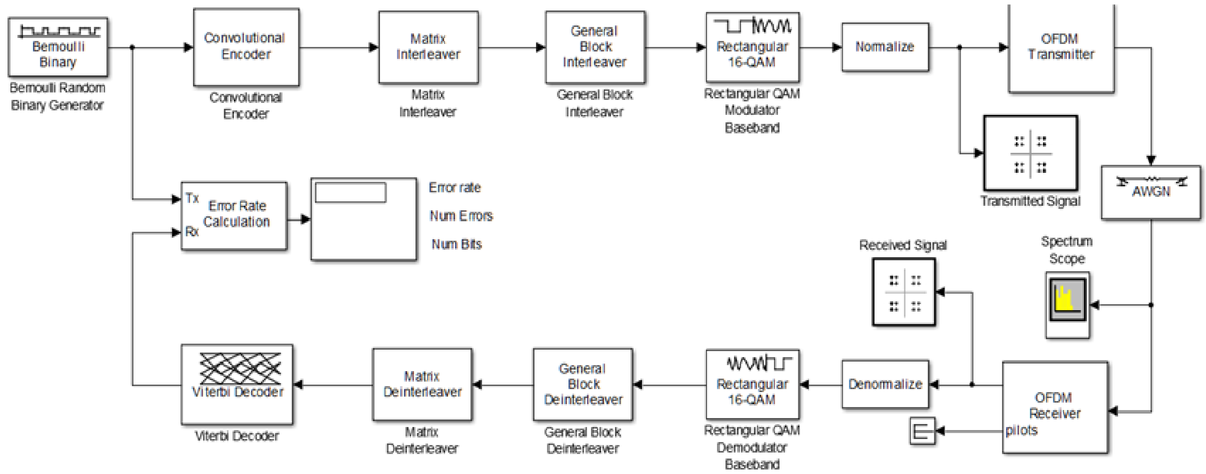

Figure:1 Block diagram of OFDM system with proposed model

PAPR is a ratio of the peak power and average power of a signal. The peak to average to power ratio can be expressed this formula:

$$PAPR = \frac{max|x_n|^2}{p_{avg}} \quad (1)$$

Where P_{avg} is the average power of the signal and x (n) is the OFDM signal

III. EFFECT OF PAPR REDUCTION ON SE /EE

The spectrum efficiency with the transmitted and average power is:

$$\eta_{SE} = \log_2(1 + \frac{P_t}{P_{nc}+P_{sav}+P_t}) \quad (2)$$

This equation show that the combination of the increment of $F_{xi}\sqrt{IBO.P_{oav}}$ and the decrement of the (PAPR>IBO). If the IBO is little then the SE is obtained better than the previous result while the PTS (v=8) method is applied for the PAPR reduction. EE performance of OFDM system is able to be improving by decreasing the IBO and reducing the PAPR. The data rate R can be improved by reducing the PAPR at this time the spectrum bandwidth is constant [12].

IV. HPA MODEL

We Simplified Circuit diagram of Class-A HPA shown in Figure 2, and the corresponding operating characteristics and Amplitude / Amplitude characteristics are shown in Figure 3 and respectively, where the amplifier gain is denoted as Gh. The operating point of the HPA is set as the IBO (input back off), which is defined as [12]:

IBO = 10 log10 Pmax /Pavg (3)

where Pmax denotes the saturation input power of the HPA, and Pavg is the average power of the input signals .

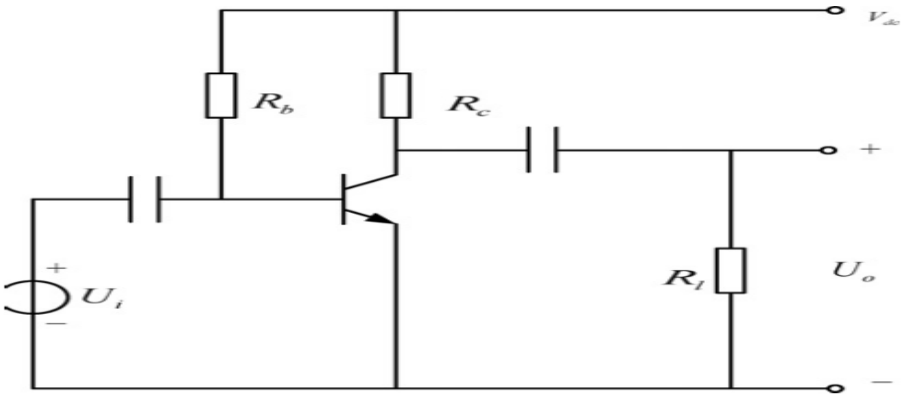

Figure: 2 Simplified Circuit diagram of Class-A HPA

V. RESULT AND SIMULATION

The research paper shows the energy efficiency and spectrum efficiency with four techniques in this graph such as Clipping, PTS 4, PTS 8 and New OFDM in terms of bits/joule and bits/s/Hz. These techniques are simple and low complexity techniques. Clipping technique is used to the recovery of the receiver signal. We calculated EE is 6.2400 bits/joule and the SE is 3.5399 bits/s/Hz by clipping technique. PTS 4 have the no of subcarrier of a signal is 4 and the phase weight is 2 and the phase factor lies between 1 to -1. We calculate Energy efficiency 1.1099bits/joule and the Spectral efficiency is 4.2300bits/s/Hz by this technique. PTS8 have the 8 subcarriers then the energy efficiency is 4.1199 bits/joule and the Spectrum efficiency is 4.2300bits/s/Hz. There is one condition is satisfied that given as:

$$PAPR < N+1 \qquad (4)$$

PTSNEW have the 64 no. of subcarriers, 1 oversampling, 4 pilot symbol, 128 no of bits, 80 Hz bandwidth and using the M=2^b QAM modulation type. All techniques results are represented in table no.1 and Figure 3and 4.

Table: 1 Results of all techniques

PAPR Technique	**EE in bits/joule**	**SE in bits/s/Hz**
PTS8	4.1199	7.7800
PTS4	1.1099	4.2300
PTSNEW (OFDMNEW)	6.3199	9.5800
Clipping	3.5399	6.2400

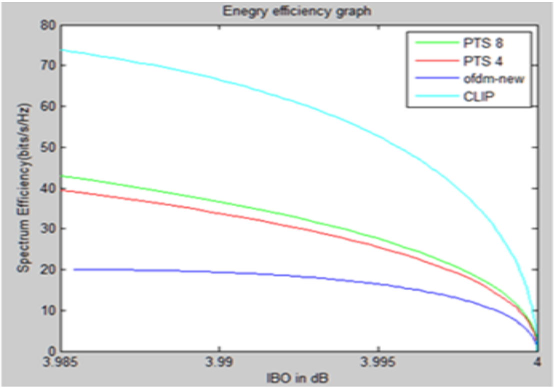

Figure:3 Energy Efficiency

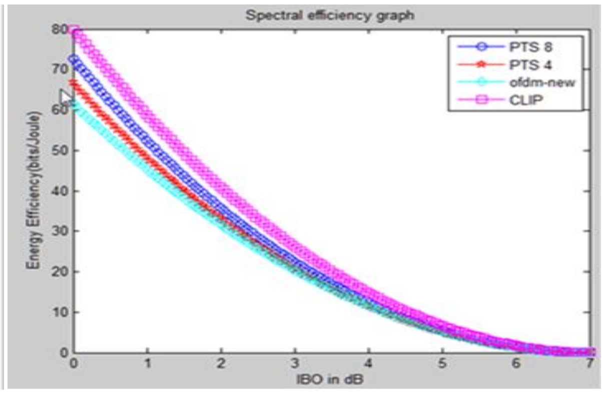

Figure:4 Spectral efficiency

The Complementary cumulative distribution function (CCDF) of PAPR with OFDM with N subcarrier is that:

$$\mathrm{CCDF}(\gamma_0) = \Pr(\mathrm{PAPR}(x[n]) > \gamma_0) \qquad (5)$$

In the figure:5 show that CCDF of OFDM signal for various factor (N) with QAM modulation and the no of subcarrier is 64 at the simulation. If the N>4 then the CCDF of PAPR is less. PAPR is proportional to the no. of the subcarriers of OFDM system. We are simulate the CCDF for the three technique like clipping, PTS 4, PTS 8 with it's original signal and have 64 no of subcarrier, 0.01 amplifier gain, 1 oversampling, and the no of symbol for PTS4 is 4 and the PTS8 is 8 and the no. of bits is 1k with adding 0.792 noise. The graph of clipping, PTS8 and the complete graph of CCDF are given that:

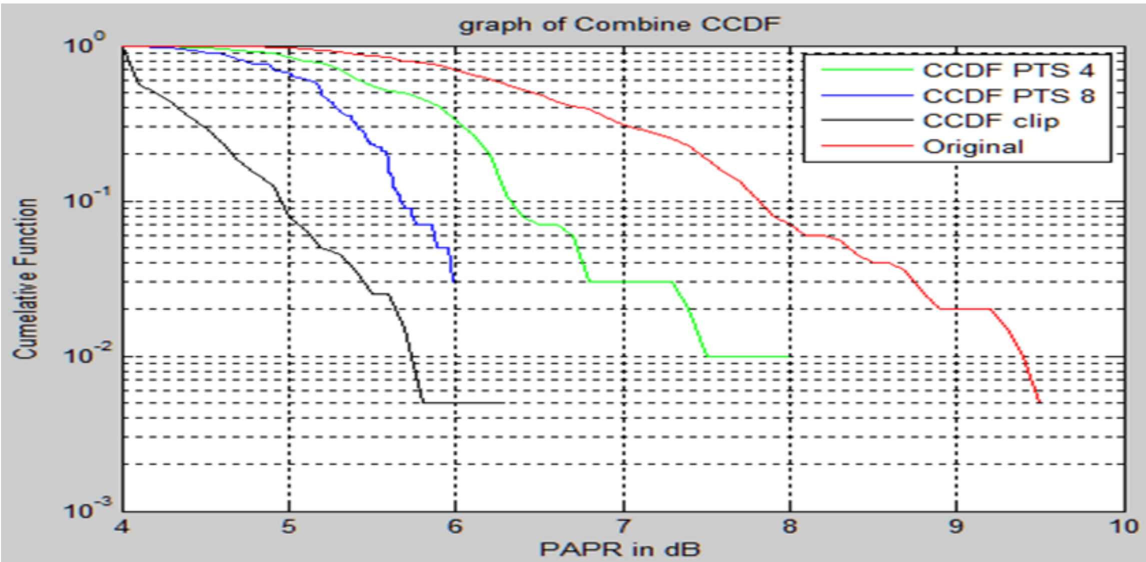

Figure: 5 CCDF of PAPR

VI. CONCLUSION

In this paper, we have analyzed the Energy efficiency and Spectral efficiency with four techniques like: Clipping, PTS4, PTS8 and PTS NEW in OFDM systems with class-A HPA. With the PAPR reduction, the power efficiency of the HPA is improved, and the nonlinear distortion noise caused by the HPA is reduced.

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