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Peak to Average Power Ratio reduction method for Orthogonal Frequency Division Multiplexing in 4G Communication

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Abstract: Recent development in data communication applications, the role of Orthogonal Frequency Division Multiplexing (FDM) technology is unavoidable. The OFDM system improves the multipath fading channel and bandwidth in effective manner. But the main problem in OFDM is large fluctuations. This often affected the design performance and produces the poor results when compared to the existing methodologies. The development and redesign of the existing system contains high power amplifiers, signal analyzer and device modules. All these devices should have the linear dynamic in range. The above devices are not functioning properly the huge data loss may occur and it will be affected the data transmission and it produces the interference in signals and inter modulation distortions. Hence, the overall power performance of the system is very poor and it makes the system in unconditional. In this paper we discussed Peak to Average Power Reduction (PAPR) techniques with HPA (High Power Amplifier) for improvement of overall response of the system.

Keywords: Peak to Average Power Ratio, Orthogonal Frequency Diviosion Multplexing, High power amplifier, Power reduction, Signal to Noise Ratio

1. INTRODUCTION

In OFDM data streams are transmitting simultaneously and it will reduce the dispersion in time caused by multipath delay is reduced and improved the transmitting speed and reduced the Inter Symbol interference (ISI) [1]. The different kind of research challenges are still discussing in OFDM and producing the better result with different challenging task [2-5]. One of the challenging task in these researchers is Inter Symbol Interference. Mainly it will occur due to different components. The non linearity amplifier produces the large peak to average ratio. The oscillator creates the phase noise problems and the receiver requires the frequency correction [6-7]. In order to avoid such kind of problem and reduce the fluctuation, the power amplifier needs better design procedure for PAPR. But most of the available techniques are reduced the performance of amplifiers [8]. Hence, the PAPR reduction is most important for the distortion less transmission in OFDM.

2. LITERATURE SURVEY

The PAPR technique mainly classified in to Signal Scrambling Techniques and Signal Distortion Techniques [8-12]. The different techniques comparison table is given in Table 1.

The recent development of new GS-SLM and GS-PTS systems are not required transmission of side information and these techniques are providing better PAPR performance [13]. The hardware reduction and improve the performance adaptive approach has been adopted in many applications [14].

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Table 1
Comparision of different techniques

Techniques	*Methods*	*Merits*	*Demerits*
		Signal Scrambling Techniques	
Block Coding Techniques	QPSK Modulation	Accuracy in output and System on a Programmable Chip	Low peak power message samples only used.
Block Coding Scheme with Error Correction	Matrix and Encoding	Minimize the PAPR, with error correction capability.	Complexity in mathematical calculations.
Selected Mapping (SLM)	SLM with IFFT	Low PAPR value.Simultaneous operation.	Complexity in coding
Interleaving Technique	Adaptive Interleaving (AL)	Less complex than the PTS (Partial Transmit Sequence) technique.	In accuracy in results. Need Improvement in results.
Tone Reservation (TR)	Convex problem	Less data set are used.	Not suitable for large data streams.
Tone Injection (TI)	General Additive method	Data losses are less.	More mathematical knowledge need for signal analyse.
		Signal Distortion Techniques	
Peak Windowing	Window	Removes Large peaks in PAPR. Self interference.	Signal distortion is limited to 0.3dB it makes the Loss in SNR.
Envelope Scaling	QPSK Modulation with IFFT.	Improved SNR about 4dB.	Appropriate only for QPSK.
Peak Reduction Carrier	PSK Modulation High order modulation	Effective PAPR techniques.	Need excessive side information for limiting BER degradation.
Clipping and Filtering	Classical Clipping (CC), Heavy side Clipping (HS), Deep Clipping (DC) and Smooth Clipping (SC)	Simple and Effective	Affect the spectral efficiency. Increase Computational Complexity.

3. PROPOSED DESIGN

a. Multi carrier system

The complex baseband representation of a multicarrier signal consisting of N subcarriers is given by

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n \cdot e^{j2\pi n\Delta ft}, 0 \le t \le T \tag{1}$$

Where Δf, is the subcarrier spacing.

In OFDM systems, the subcarriers are chosen to be orthogonal. (i.e., $\Delta f = 1/T$).

b. High PAPR

The PAPR of the transmit signal is defined as

$$PAPR = \frac{\max\limits_{0\le t\le T} \left|x(t)\right|^2}{1/T \cdot \int_0^T \left|x(t)\right|^2 dt} \tag{2}$$

In general, the PAPR of OFDM signals $x(t)$ is defined as the ratio between the maximum instantaneous power and its average power. The proposed design is given in Fig.1. The Carrier Frequency Offset (CFO)

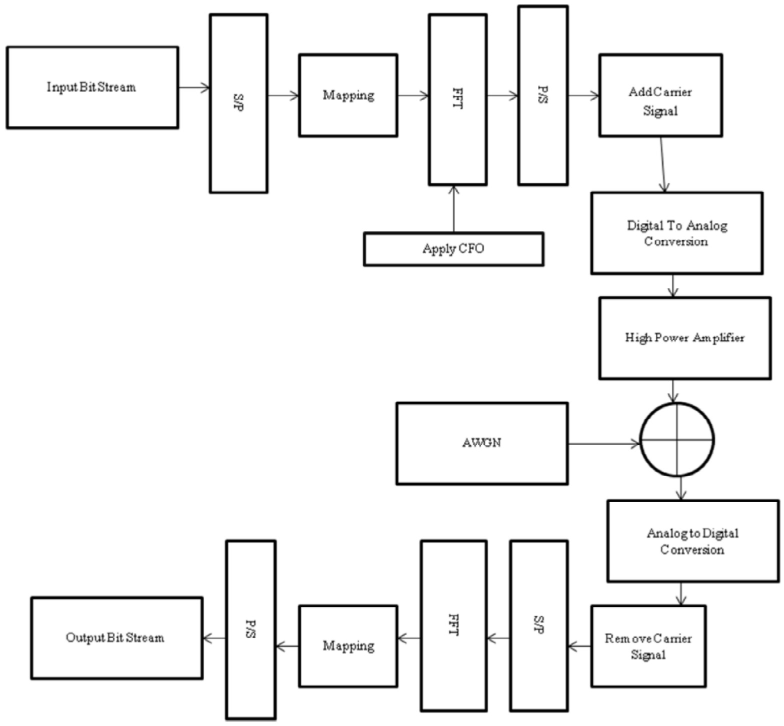

Figure 1: Block diagram of proposed design

is prominent. In this proposed design OFDM-FFT (Fast Fourier Transform) transformation is linked with CFO for performance evaluation of Addictive White Gaussian Noise (AWGN) in 4G communication.

4. SIMULATION RESULTS

Simulation Parameters, Size of OFDM Symbol $N = 5$, Number of OFDM symbols to be simulated $m = 8$, Size of Alphabet $M = 6$, Type of Mapping (1 for PSK) and (2 for QAM) = 1, Cconstellation phase offset = 0.3, Constellation Symbol Order (1 for Binary), and (2 for Gray) = 1, size of cyclic prefix samples Ncp = 5, the table 2 shows the SNR values in every step out of 16 steps.

Table 2
SNR values

Steps	*SNR*
1	0
2	2
3	4
4	6
5	8
6	10
7	12
8	14
9	16
10	18
11	20
12	22
13	24
14	26
15	28
16	30

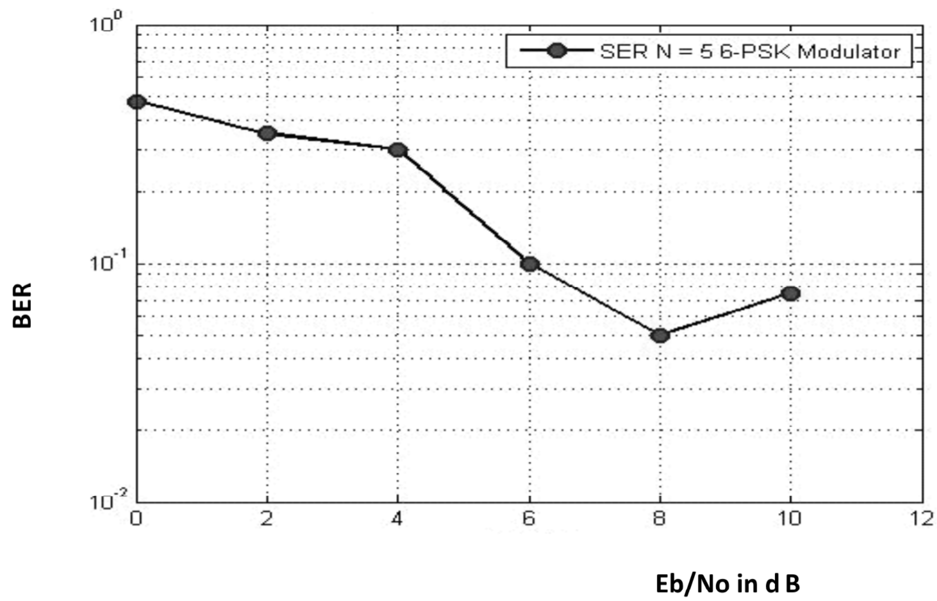

Figure 2: OFDM Symbol Error Rate

a. OFDM System simulation with various CFO under AWGN

nDSC	=	256;
nCP	=	16;
Number in FFT	=	256;
CFO	=	0:0.05:0.2
BER	=	zeros(1, length(EbN0dB))
MC	=	5000

i. *Gaussian noise of unit variance*,

$$nt = 1/\text{sqrt}(2)*(\text{randn}(1, n\text{Tot}) + 1i*\text{randn}(1, n\text{Tot})) \tag{3}$$

$$yr = \text{sqrt}(n\text{Tot}/\text{nFFT})*\text{xtt} + 10\text{\^{}}(-\text{EsN0dB}(n)/20)*n \tag{4}$$

ii. *applying CFO*

$$\text{cfo}=(\exp(1ei*2*pei*\text{CFO}(ii)*(0:\text{length}(\text{cfo})-1)/\text{nFFT}))*\text{cfor} \tag{5}$$

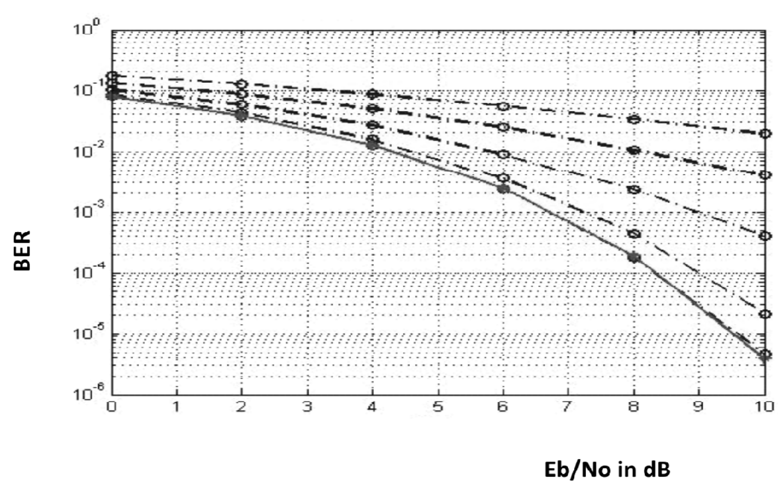

Figure 3: OFDM system simulation with various CFO under AWGN

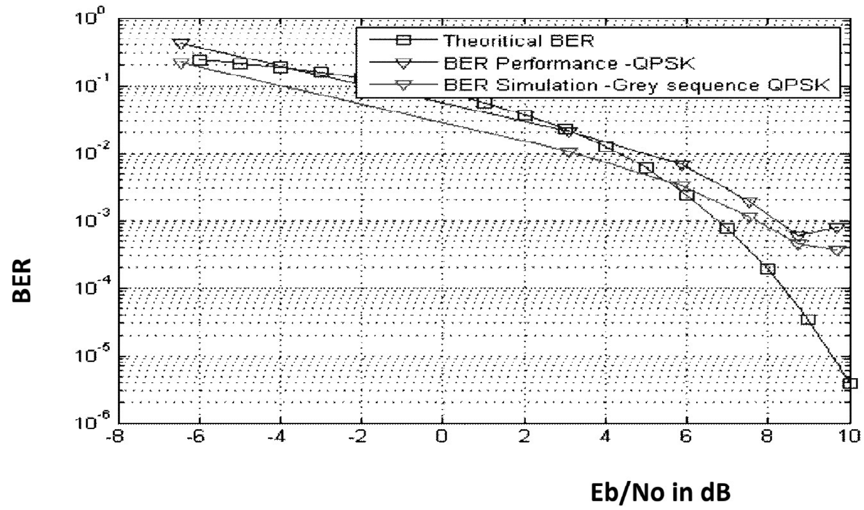

Figure 4: Bit Error probability curve for OFDM

The performance of the proposed design is evaluated by theoretical design and verified by MATLAB simulation. In this simulation nonlinear AWGN channel 10,000 OFDM symbols is used. The data is randomly generated with PSK modulation and QPSK. The PAPR reduction capability "power efficiency" of the proposed design reaches 75% of original PAPR on the average. This is demonstrated in Figs. 2 to 4, which shows simulated OFDM Symbol error rate with Signal to Noise Ratio (SNR) and OFAM with various CFO under AWGN. The Grey sequence QPSK produced the better results

5. CONCLUSION

The selected proposed design provides a good range in performance to reduce PAPR problem in OFDM. The simulation results are proved that the efficiency of the proposed design. This technique is suitable for the OFDM system with more number of subcarriers. In future this work can be extended to implementation of MIMO-OFDM in 4G communication with reduced PAPR in real time applications.

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