ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 10, October 2013

REDUCTION OF PAPR IN OFDM USING CROSS GRID APPROACH OF SLM AND CLIPPING

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Abstract- Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation scheme, which is frequently used in various wireless communication systems. There are several kinds of challenges in front of the wireless communication system. The OFDM performs these tasks very well by carrying multicarrier into one single channel but there are problems in the implementation of the OFDM completely. One of the major problems in OFDM system is PEAK TO AVERAGE POWER RATIO (PAPR). High PAPR results from large envelope fluctuations in OFDM signal which requires a highly linear power amplifier (PA).This paper focuses on the reduction of the PAPR using a definite change in the phase shift which occurs in the previous works done. A new phase has been introduced into the contrast reducing the main phase by one degree of computation. Previous researchers have put three phase changes for the co ordination of N=128 and N=256 where as per the new approach in this paper, there would be four phase changes as defined earlier. The phase shift has been performed along with two techniques and their combination namely SLM, CLIPPING and HYBRID (SLM+CLIPPING) TECHNIQUE

Keywords: OFDM, PAPR, Power Amplifier, SLM, Clipping.

INTRODUCTION

Digital communications systems require each channel to operate at a specific frequency and with a specific bandwidth. In fact, communication systems have evolved so that the largest amount of data can be communicated through a finite frequency range [1]. In this section we will focus on the recent evolution of communications systems into using various mechanisms for effectively using the frequency spectrum. More specifically, we will describe how frequency division multiplexing (FDM) and [2] orthogonal frequency division multiplexing (OFDM) are able to effectively utilize the frequency spectrum. In addition, we will distinguish the two and describe why OFDM systems are currently being implemented in some of the newest and most advanced communications systems. Orthogonal Frequency Division Multiplex or OFDM [1][2][3][4] is a modulation format that is finding increasing levels of use in today's radio communications scene. OFDM has been adopted in the Wi-Fi arena where the 802.11a standard uses it to provide data rates up to 54 Mbps in the 5 GHz ISM (Industrial, Scientific and Medical) band. In addition to this the recently ratified 802.11g standard has it in the 2.4 GHz ISM band. In addition to this, it is being used for WiMAX and is also the format of choice for the next generation cellular radio communications systems including 3G LTE and UMB. Although OFDM systems are very effective in terms of carrying multichannel subcarriers but there are few problems in the OFDM systems. Peak to Average Power Ratio (PAPR)[1][2][3][4][5] is one of the major problems which occur in OFDM systems .

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PAPR= $|X_{peak}{}^2| / |X_{rms}{}^2|$ [15]
CREST FACTOR= $|X_{peak}| / |X_{rms}|$

1.1 WHY PAPR OCCUR

The PAPR is the relation between the maximum powers of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol. PAPR occurs when in a multi-carrier system the different sub-carriers are out of phase with each other [6]. At each instant they are different with respect to each other at different phase values. When all the points achieve the maximum value simultaneously; this will cause the output envelope to suddenly shoot up which causes a 'peak' in the output envelope. Due to presence of large number of independently modulated sub- carriers in an OFDM system, the peak value of the system can be very high as compared to the average of the whole system. This ratio of the peak to average power value is termed as Peak-to-Average Power Ratio. An OFDM signal consists of a number of independently modulated sub-carriers which can give a large PAPR when added up coherently. When N signals are added with the same phase they produce a peak power that is N times the average power of the signal. So OFDM signal has a very large PAPR, which is very sensitive to nonlinearity of the high power amplifier. In OFDM, a block of N symbols{X , k = 0,1,....,N -1} k , is formed with each symbol modulating one of a set of subcarriers, {f , k = 0,1,.....,N -1} k . The N subcarriers are chosen to be orthogonal, that is, fkf k = D, where Df =1 NT and T is the original time [8] period.

II. TECHNIQUES WHICH ARE HELPFUL IN THE REDUCTION OF PAPR

A. SLM : In SLM technique from a single OFDM sequence D having a length of N, number of sequences are generated that represent the same information using some rotation factors and the sequence with lowest PAPR is transmitted. If the number of generated new sequences is U, called the SLM length, then all these sequences are the result of multiplying the incoming original OFDM sequence D by U different rotation factors. Figure (1) - convention SLM Technique

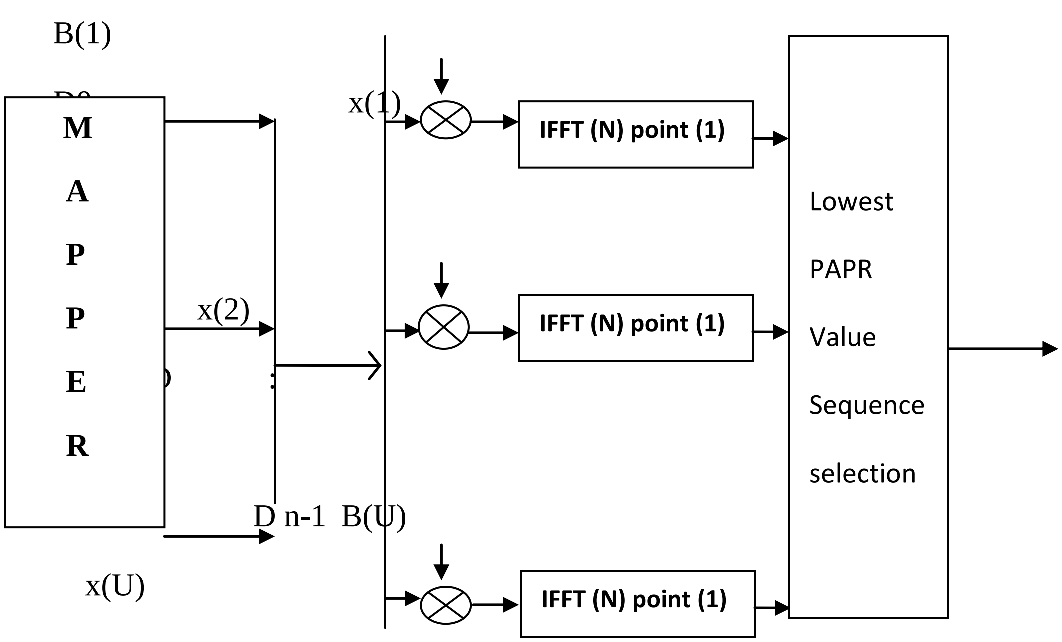

Figure 1: SLM MODE for PAPR REDUCTION

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B. Clipping: Clipping is a simple technique in which it clips the OFDM signal which is above the threshold limit .The frequency measure is calculated in the time domain sample. Without filtering, clipping causes out-of-band radiation. Digital filtering is present to control out-of-band radiation. Time domain signal is obtained by IFFT. Then clipping is applied and frequency domain signal is obtained by FFT. Then filtering is used.

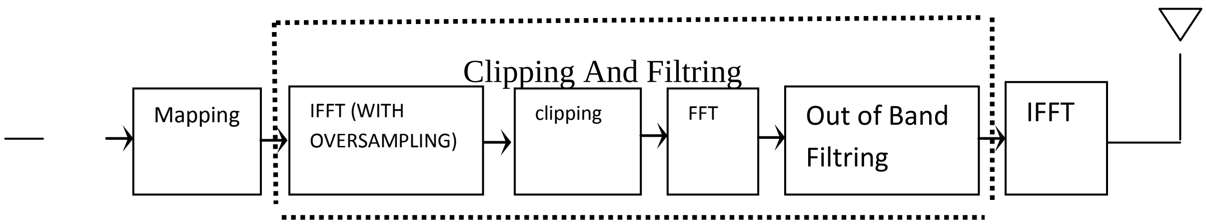

Figure 2: General Clipping Mode

III. RELATED WORK

Due to the presence of PAPR in the OFDM subsystems 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 inter modulation 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. These large peaks cause saturation in power amplifiers, leading to inter modulation products among the subcarriers and disturbing out of band energy [4]. Therefore, it is desirable to reduce the PAPR. To reduce the PAPR, several techniques have been proposed such as clipping, coding, peak windowing, Tone Reservation and Tone Injection. But, most of these methods are unable to achieve simultaneously a large reduction in PAPR with low complexity, with low coding overhead, without performance degradation and without transmitter receiver symbol handshake. The high capability of PAPR reduction is primary factor to be considered in selecting the PAPR reduction technique with as few harmful side effects such as in-band distortion and out-ofband radiation.

IV. RESEARCH METHODOLOGY

The reason behind the combination of the SLM [5] with Clipping is that Clipping works on a fixed time domain where as the Selective mapping works on iterations. The previous researchers have contributed on subcarriers N=128 and 256 using M QAM modulation and M PSK modulation. All the PAPR is based on the phase changes which is defined by

$$Phi=2k\pi/M$$

where M=[4,5,6] and k=[0,1,2,…M-1] and then the least value is calculated at the end .In our research work instead of only combining the SLM

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and CLIPPING we have also introduced a new phase value i.e for M=3. All the previous approach has been kept the same whose details have been given below:

a) Starting with a set of N data symbols representing an OFDM frame.

b) Rotating all constellation vectors using the phase table which would be generated when we would pass the phase values of M

c) Changing the data into the time domain signal

d) Compute the PAPR for all variants and calculating the least value of the PAPR in all domains.

V. NUMERICAL RESULTS

We have simulated the results using N=128 and N=256 with M= [3,4,5,6] where M represents a major factor in the phase shift.

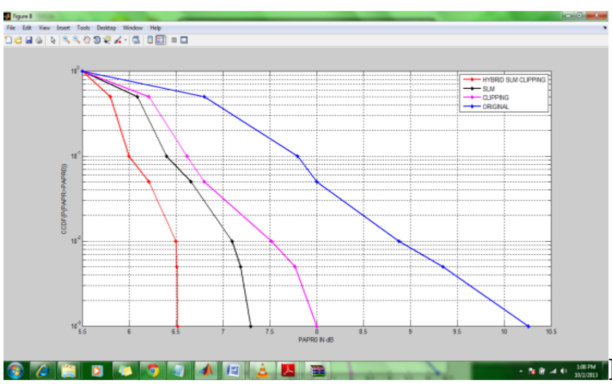

Figure 3: PAPR for N=128

Figure 3 represents the PAPR plot in db with the new approach in which the original PAPR in which the hybrid approach emphasis a better result of 6.5 db with additional phase shift where as if we compare it with the previous approach [14] it comes out to be 7 where as the original signal has PAPR= 11.1 db

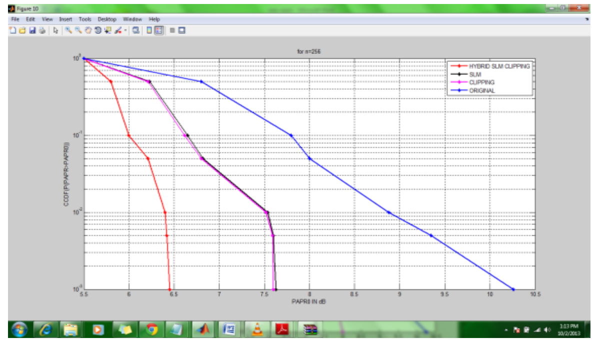

Figure 4: PAPR for N=256

Figure 4 represents the hybrid approach of SLM and CLIPPING with four phase changes and it comes out to be 6.45 db which is efficient than the previous approach as mentioned in [14].

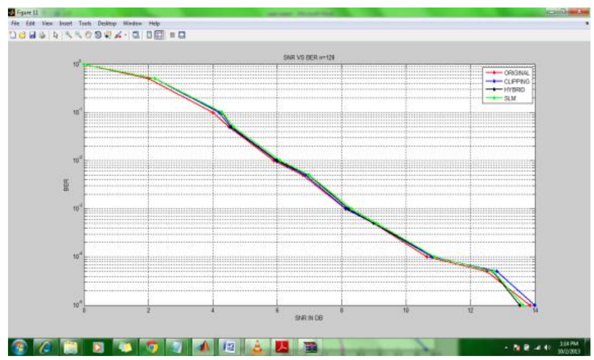

Figure 5: SNR vs BER N=128

Figure 5 represent the analysis of SNR VS BER for N=128 in which the hybrid approach result comes out to be 13.53 db for SNR where as the previous approach as mentioned in [14] is 13.50.

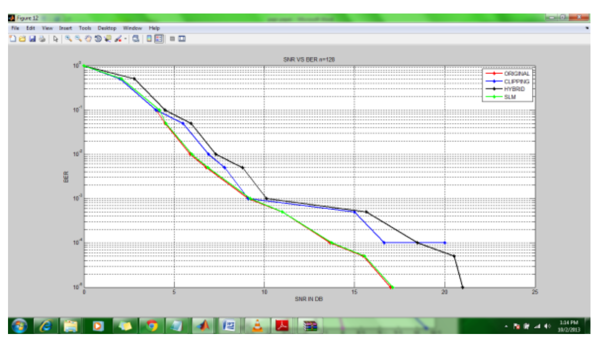

Figure 6: SNR VS BER for N=256

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Figure 6 represent the study of the SNR vs BER for N=256 in which the hybrid approach stand taking a clear edge over the previous results as mentioned in [14].

With the experimental result done, the results which came out are as follows.

For N=128, the hybrid approach ends with PAPR 6.6 db where as for N=256 PAPR comes out to be 6.4 db .Talking about the SNR for N=128, the SNR of the hybrid approach comes out to be 13.85 which is better than the previous result where as the SNR for 256 is also better.

VI. CONCLUSION AND FUTURE SCOPE

With the change in phase the results are modified and come out with better efficiency but there is always a chance of modification in work done. The future researchers can change the modulation technique as we have used QAM and PSK for better enhancement.

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BIOGRAPHIES

Parvinder Singh is working as Associate Professor in RIEIT,Railmajra. He has completed his m-tech degree in from DAV, Jalandhar and completed b-tech in 2005 with honors from RIEIT, Railmajra. He has more than 8 years of teaching experience. He has done his m-tech thesis in field of wireless personal area network technology. He has also guided 5 m-tech thesis and 2 students of m-tech are under current supervision. He has published five papers in various reputed international journals and four papers in national conferences and he has also published one in IEEE conference.

Misha Arora is pursuing m-tech from rieit,railmajra. Her work of interest is OFDM and techniques of reducing PAPR in OFDM Systems. Further on she would like to pursue P.hd in the same field.