ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 5, May 2016

PAPR Reduction Technique by Using Clipping Method.

Jaimin Sojitra
M.Tech Student
Indus University

Omkar Pabbati
Assistant Professor
Indus University

Divyangna Gandhi
Assistant professor
Indus University

Abstract— In recent years, there is rapid growth in multimedia based on applications, which require technologies that can support high speed data transmission. Frequency Division Multiplexing (OFDM) is a widely used to achieve this goal. OFDM system uses Orthogonality concept for subcarriers and also uses available bandwidth efficiently. However as number of subcarriers in OFDM increases, the Peak to average power ratio (PAPR) increases. This high PAPR causes significant distortions when passed through non-linear amplifier. To reduce PAPR, a number of promising techniques have been proposed & implemented. In this paper, The BER performance of clipping method for PAPR reduction is evaluated. It is found from simulations results that clipping technique gives improvement in PAPR reduction.

Keywords: Bit-Error Rate, Cyclic Prefix, Inter Carrier Interference, Inverse Fast Fourier Transform, Orthogonal Frequency Division Multiplexing, Peak-to-Average Power Ratio

I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is one of the multi-carrier modulation (MCM) techniques that transmit signals through multiple carriers. These carriers (subcarriers) have different frequencies and they are orthogonal to each other. Orthogonal frequency division multiplexing techniques have been applied in both wired and wireless communications, such as the asymmetric digital subscriber line (ADSL) and the IEEE 802.11 standard.[1]

Orthogonality concept is used in the OFDM system. The key to OFDM is maintaining Orthogonality of the carriers. If the integral of the product of two signals is zero over a time period, then these two signals are said to be orthogonal to each other. Two sinusoids with frequencies that are integer multiples of a common frequency can satisfy this criterion. OFDM communications systems are able to more effectively utilize the frequency spectrum through overlapping sub-carriers. These sub-carriers are able to partially overlap without interfering with adjacent sub-carriers because the maximum power of each sub-carrier corresponds directly with the minimum power of each adjacent channel. OFDM technique has potential of enhancing the data rate in band limited channel.

Over the last decade a lot of research has been carried out in reducing the two major limitations of OFDM to enhance the performance of the system. One of them is the sensitivity of OFDM signal against carrier frequency offset which causes Inter Carrier Interference (ICI) which is undesired and another one is the large variation in the envelope of OFDM signal, which causes high peak-to-average power ratio (PAPR)[4]. OFDM have several attractive features which make it more advantageous for high speed data transmission over other data transmission techniques, The main advantage of the OFDM system is its ability to convert a frequency selective fading channel into several nearly flat fading channels as the entire available spectrum is divided into a number of narrow band sub channels, Easy equalization, The highest spectral efficiency of the system is obtained by overlapping the orthogonal frequency responses of the sub channels.

Apart from ICI, Other problem emerging in OFDM systems is the PAPR. At the transmitter side, the input symbol stream of the IFFT should possess a uniform power spectrum, but the output of the IFFT may result in a nonuniform or spiky power spectrum. Most of transmission energy would be allocated for a few instead of the majority subcarriers. This problem can be quantified as the PAPR measure. It causes many problems in the OFDM system at the transmitting end.

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 5, May 2016

II. OFDM SYSTEM Model

Figure 1 shows the block diagram of a typical OFDM transceiver. In transmitter section Serial to parallel block, each channel can be broken into various sub-carriers. The use of sub-carriers makes optimal use out of the frequency spectrum but also requires additional processing by the transmitter and receiver. This additional processing is necessary to convert a serial bit stream into several parallel bit streams to be divided among the individual carriers. Once the bit stream has been divided among the individual sub-carriers, each sub-carrier is modulated as if it was an individual channel before all channels are combined back together and transmitted as a whole. The receiver performs the reverse process to divide the incoming signal into appropriate sub-carriers and then demodulating these individually before reconstructing the original bit stream. In IFFT block, the modulation of data into a complex waveform occurs at the Inverse Fast Fourier Transform (IFFT) stage of the transmitter. Here, the modulation scheme can be chosen completely independently of the specific channel being used and can be chosen based on the channel requirements. In fact, it is possible for each individual sub-carrier to use a different modulation scheme. The role of the IFFT is to modulate each sub-channel onto the appropriate carrier.

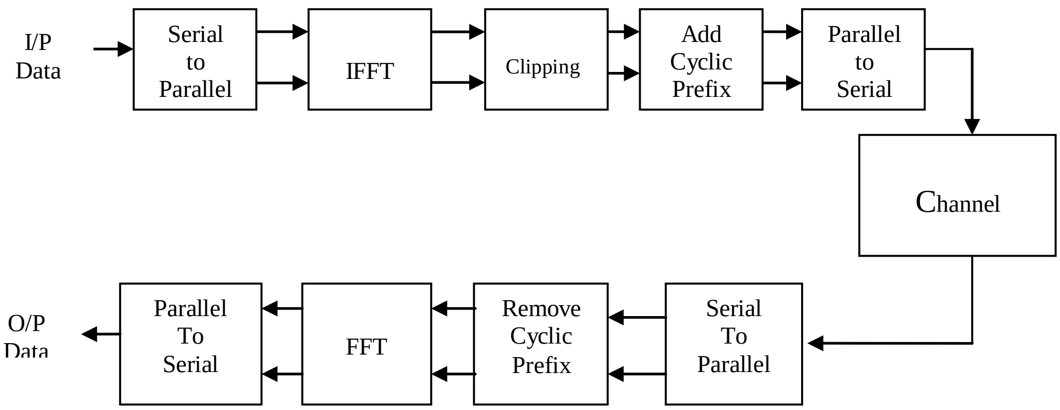

Fig.1 Block Diagram of OFDM system

In Cyclic Prefix Insertion block, Inter-symbol interference is caused when delayed and attenuated versions of the signal overlap with signal. Hence one symbol's delayed version may overlap with an adjacent symbol causing inter-symbol interference. One simple technique to avoid this is to introduce a guard-band between adjacent symbols. However, a better approach is to introduce a cyclic prefix where some trailing portion of the Symbol is copied in front of it. In Parallel to Serial Conversion block, Once the cyclic prefix has been added to the sub-carrier channels, they must be transmitted as one signal. Thus, the parallel to serial conversion stage is the process of summing all sub-carriers and combining them into one signal. As a result, all sub-carriers are generated perfectly simultaneously. At the receiver side reverse process of the transmitter's process.

III. PAPR reduction techniques

PAPR can be defined as the relationship between the maximum power of a sample in a transmit OFDM symbol and its average power [4].

$$PAPR = 10\log_{10}\frac{P_{Peak}}{P_{Average}}\ (dB)$$

PAPR reduction techniques vary according to the requirement of the system and are dependent on various factors such as PAPR Spectral efficiency, reduction capacity, increase in transmit signal power, loss in data rate, complexity of computation and increase in the bit-error rate (BER) at the receiver end are various factors which are taken into account before adopting a PAPR reduction technique of the system [1]. Many techniques have been suggested for PAPR reduction, with different levels of success and complexity lot of techniques presents for the reduction of this PAPR. These techniques are divided into two groups – signal scrambling techniques and signal distortion techniques which are given below:

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 5, May 2016

In Signal Scrambling Techniques includes Block Coding Techniques, Selected Mapping (SLM), Partial Transmit Sequence (PTS), Tone Reservation (TR), Tone Injection (TI).

In Signal Distortion Techniques includes Peak Windowing, Peak Reduction Carrier, and Clipping

IV. PAPR Analysis

Each method has some drawback if we reduce PAPR, so some basic Criteria for selection of PAPR reduction technique, there are many factors that should be considered before a specific PAPR reduction technique. These factors include PAPR reduction capability, power increase in transmit signal, BER increase at the receiver, loss in data rate, computational complexity increase, and so on. An effective PAPR reduction technique should be given the best tradeoff between the capacities of PAPR reduction

V. Clipping Method

The clipping method limits the peak envelope of

Table 1. Comparison of PAPR reduction techniques

Name of Techniques	Power Increase	BW Expansion	BER Degradation	Complexity	Data rate loss
Block Coding	No	Yes	No	Low	Yes
PTS	No	Yes	No	High	Yes
SLM	No	Yes	No	High	Yes
TR	Yes	Yes	No	High	Yes
TI	Yes	Yes	No	High	NO
Clipping	No	No	Yes (Very low)	Low	NO

Table 2. Comparison of PAPR reduction techniques with Complexity

Name of Techniques	Require processing at transmitter (Tx) and receiver (Rx)	Complexity
Block Coding	Tx: Encoding or table search Rx: Decoding or table search	Low
PTS	Tx: M IDFTs, WM–1 complex vector sums Rx: Side information extraction, inverse PTS	High
SLM	Tx: U IDFTs Rx: Side information extraction, inverse SLM	High
TR	Tx: IDFTs, find value of PRCs Rx: Ignore non-data-bearing subcarriers	High
TI	Tx: IDFTs, search for maximum point in time, tones to be modified, value of p and q Rx: Modulo-D operation	High
Clipping	Tx: Amplitude clipping Rx: None	Low

input signal in the time domain to a predetermined value. However, the distortion caused by the amplitude clipping is viewed as another source of noise. The clipping method does not reduce the frequency efficiency, but causes in-band interference due to the peak reduction signal.

This method is the method of clipping the high peaks of the OFDM signal prior to passing it through the Power Amplifier (PA).

This method employs a clipper that limits the signal envelope to a predetermined clipping level (CL) if the signal exceeds that level; otherwise, the clipper passes the signal without change [3].

$$T(x[n]) = \begin{cases} x[n] & if \quad |x[[n]| \leq CL \\ CLe^{j\angle x[n]} & if \quad |x[n]| > CL \end{cases}$$

peaks of the OFDM signal prior to passing it through the PA. This method employs a clipper that limits the signal envelope to a predetermined clipping level (CL) if the signal exceeds. The input symbol stream of the IFFT should possess a uniform power spectrum, but the output of the IFFT may result in a non uniform or spiky power spectrum. Most of transmission energy would be allocated for a few instead of the majority subcarriers. This problem can be quantified as the PAPR measure. So clipping block should be after output of IFFT. In the Fig 1, clipping block is between IFFT and Cyclic prefix. First Convert the OFDM symbol to time domain as Xn =IFFT (Xk), where Xk is transmitted OFDM signal.

In the clipping block, Clip Xn to the threshold A and output of clipped signal passed through Add cyclic prefix block to the end of the receiver side

VI. SIMULATION RESULTS

Simulations parameter are used during simulations results as below,

Table 3. Simulations parameter

Parameters	Value used
Number of sub carriers	210
Modulations scheme	BPSK / QPSK
Total number of Combinations of IFFT	1024
Symbol per carrier	50
SNR	0 to 30
Channel	AWGN

Figure 2 shows that comparison of BER performance for BPSK, QPSK and 8QAM. For example at the 20 dB of SNR, the value of BER is 2×10^{-2}, 1×10^{-1}, $4 \times 10^{-1}$for BPSK, QPSK and 8QAM respectively. It shows that BER performance degrades with the higher modulations schemes

At BER 1×10^{-2} , SNR is 21dB, 25dB, 30dB for BPSK, QPSK and 8QAM respectively. There is 4dB improvement in BPSK as compared to QPSK and 10dB improvement in BPSK as compared to 8QAM.

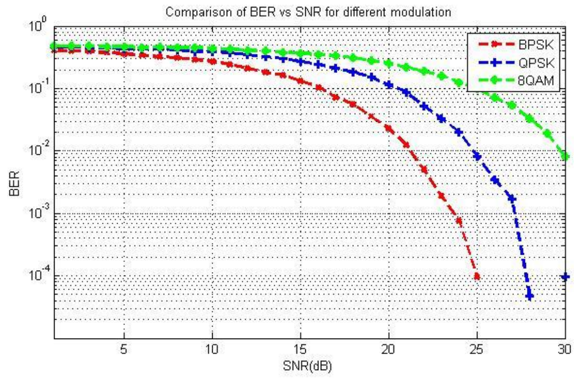

Fig. 2 Comparison of BER Vs SNR for modulation techniques for OFDM system

Thus it cleared that OFDM system with BPSK modulation gives better performance in terms of Bit Error Rate (BER) compared to QPSK and 8QAM.

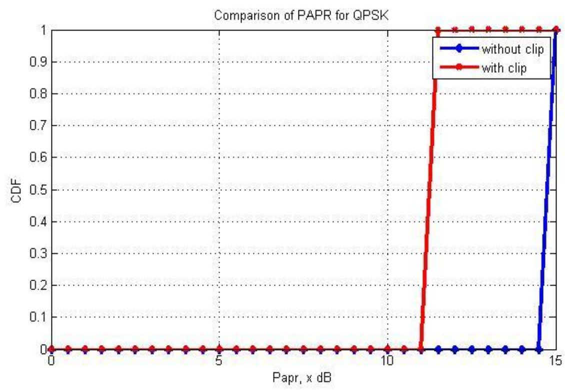

Fig 3. CDF Vs PAPR for QPSK

Figure 5.3 shows that PAPR performance for OFDM system using without clipping and with clipping technique for QPSK. For an example, at CDF of 0.5, the value of PAPR without clipping method is 14.5 dB and for the same CDF, the value of PAPR with clipping method is 11.5 dB. From this example it can be clear that there is a 3.0 dB improvement using clipping method as compare to without clipping method for QPSK modulation.

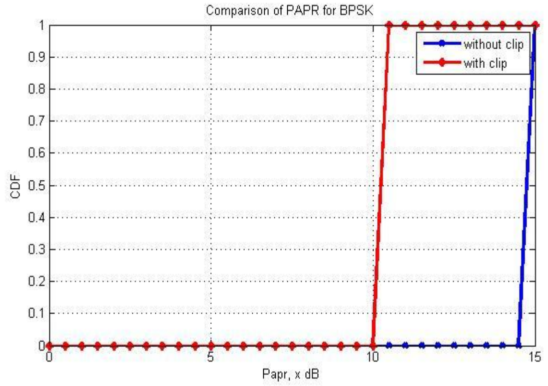

Fig 4. CDF Vs PAPR for BPSK

Figure 5.4 shows that PAPR performance for OFDM system using without clipping and with clipping technique for BPSK. For an example, at CDF of 0.5, the value of PAPR without clipping method is 14.5 dB and for the same CDF, the value of PAPR with clipping method is 10.2 dB. From this example it can be clear that there is a 4.3 dB improvement using clipping method as compare to without clipping method for BPSK modulation

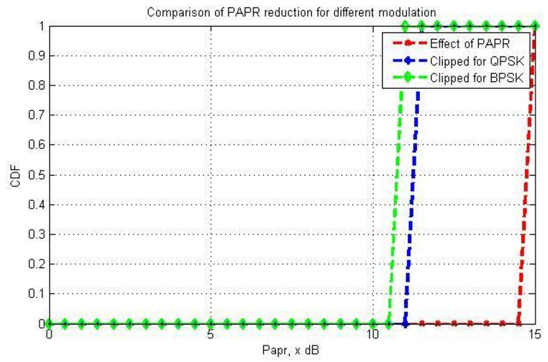

Fig 5. Comparison of PAPR reduction for BPSK and QPAK

Figure 5 shows that comparison of clipping method for BPSK and QPSK. From figure, effect of PAPR in OFDM system is 14.5 dB. With clipping method PAPR is 11.5 dB and 10.5 dB for QPSK and BPSK respectively. Here at CDF of 0.5 reduced PAPR to 11.5 dB and 10.5 dB for QPSK and BPSK respectively. There is 4dB improvement in BPSK as compared to QPSK

For an example, at CDF of 0.5, the value of PAPR without clipping method is 14.5 dB and for the same CDF, the value of PAPR with clipping method is 11.5 dB and 10.5 dB for QPSK and BPSK respectively. From this example it can be clear that there is a 1.0 dB improvement using clipping method as compare to without clipping method for QPSK modulation.

.

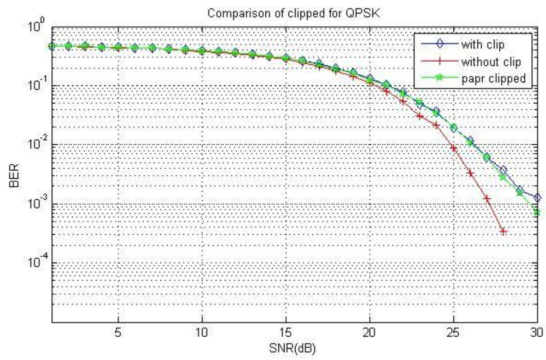

Fig 6. Comparison of clipped for QPSK

Figure 6 shows the BER performance of signal without clip, with PAPR clipped for QPSK modulation scheme. This shows that at the same value of 20 dB SNR. the value of BER is 1×10^{-1} , 2×10^{-1}, 2×10^{-1} for without clip, with signal clip and PAPR clipped respectively. BER performance is going to degrade using clipped method in QPSK.

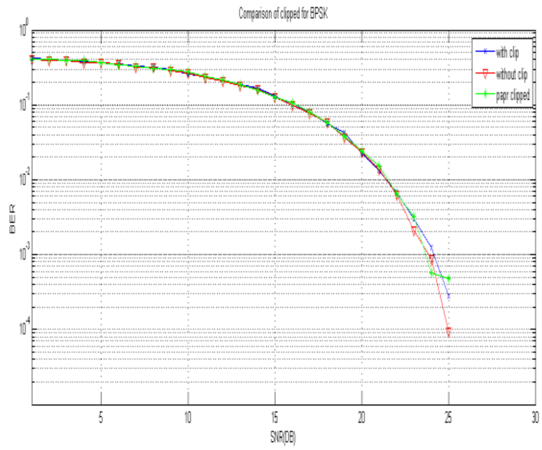

Fig.7 Comparison of clipped for BPSK

Figure 7 shows the BER performance of signal without clip, with PAPR clipped for BPSK modulation scheme. This shows that at the same value up to SNR 20 dB, the value of BER 2×10^{-2} is same for without clip, with signal clip and PAPR clipped. With increasing value of SNR, BER performance is very low degradation. From the figure 7 , it can observe that the PAPR is reduced for both BPSK and QPSK but in BPSK the PAPR reduction is more as compared to the QPSK.

V. Conclusion

An effective PAPR reduction techniques gives tradeoff between the capacity of PAPR reduction and transmission power, data rate loss, implementation complexity and Bit-Error-Ratio (BER) performance etc. The performance of OFDM system with PAPR can be improved using clipping technique. PAPR. As compared to the QPSK modulation scheme, there is a significant reduction of PAPR in BPSK modulation scheme. BER performance degrades while using clipping method in QPSK and there is no significant degradation in BER for BPSK. It can conclude from the simulation results.

References

[1] An Overview: Peak to Average Power Ratio in OFDM system & its Effect. International Journal of Communication and Computer Technologies Volume 01 – No.2, Issue: 02 September 2012

[2] Performance Analysis of Peak-to-Average Power Ratio Reduction Techniques for Wireless Communication Using OFDM Signals, IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 6, November 2010

[3] Peak-To-Average Power Ratio Reduction in OFDM Systems: A Survey And Taxonomy IEEE Communications Surveys & tutorials, vol. 15, no. 4, fourth quarter 2013

[4] Definition of Efficient PAPR in OFDM, IEEE Communications Letters, VOL. 9, NO. 9, SEPTEMBER 2005

[5] Effects of Clipping and Filtering on the Performance of OFDM, IEEE Communications Letters, VOL. 2, NO. 5, MAY 1998

[6] OFDM with reduced peak-to-average power ratio by optimum combination of partial transmit sequences, IEE 1997 Electronics Letters Online No: 19970266

[7] A Novel Peak Power Reduction scheme for OFDM, 0-7803-3871-5/97/ 1997 IEEE

[8] Reducing the peak-to-average power ratio of multicarrier modulation by selected mapping, IEE 1996 13 September 1996 Electronics Letters Online No: 19961381

[9] Tone Injection with Hexagonal Constellation for Peak-to-Average Power Ratio Reduction in OFDM, Seung Hee Han, John M. Cioffi, Fellow, IEEE, and Jae Hong Lee, Senior Member, IEEE, IEEE COMMUNICATIONS LETTERS, VOL. 10, NO. 9, SEPTEMBER 2006

[10] PAPR Reduction in OFDM System Using Clipping and Filtering Method, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 2, February 2015

[11] An Overview of Peak-To-Average power Ratio Reduction Techniques For Multicarrier Transmission 1536-1284/05 © 2005 IEEE Wireless Communications