PAPR Reduction in OFDM system using Clipping & Filtering Technique

Patel Ved Chandrakantbhai

Student
Department of Digital Communication,RKDF College of Engineering-Rajiv Gandhi Proudyogiki, Vishwavidyalaya –Bhopal-India.
vedpatel48@yahoo.co.in

***Abstract* - Communication is one of the important aspects of life. With the advancement in age and its growing demands, there has been rapid growth in the field of communications. Signals, which were initially sent in the analog domain, are being sent more and more in the digital domain these days. For better transmission, even single – carrier waves are being replaced by multi – carriers. Multi – carrier systems like CDMA and OFDM are now – a – days being implemented commonly. In the OFDM system, orthogonally placed sub – carriers are used to carry the data from the transmitter end to the receiver end. Presence of guard band in this system deals with the problem of ISI and noise is minimized by larger number of sub – carriers. But the large Peak– to – Average Power Ratio of these signal have some undesirable effects on the system. Here we concentrate on PAPR reduction in OFDM using Clipping and Filtering technique.**

I. INTRODUCTION

Since the very genesis of man, communication has been one of the main aspects in human life .Previously various methods like sign languages were implemented for this purpose. As various civilizations started coming into existence, many innovative ideas came to the minds of the people – special birds and human messengers were employed to meet these challenges. As ages rolled by, post system developed and transportation vehicles like trains and ships were used to maintain link between people miles apart. But by the turn of the nineteenth century, a great leap in communication system was observed when wireless communication was introduced.After the advent of wireless communication huge change has been observed in the lifestyle of people.Wireless communication which was initially implemented analog domain for transfer has is now-a-days mostly done in digital domain. Instead of a single carrier in the system multiple sub-carriers are implemented to make the process easier.

II. OFDM (ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING)

Orthogonal Frequency Division Multiplexing (OFDM), most popular high speed data transmission technique, has invented before about 50 years, only in the last fewyears has its use become widespread. The main advantage of the OFDM system is itsability to convert a frequency selective fading channel in to several nearly flat fadingchannels as the entire available spectrum is divided into a number of narrow band sub channels. The high spectral efficiency in the system is obtained by overlapping the orthogonal frequency responses of the sub channels. In the OFDM, the symbol duration Tis relatively larger than high data rate input bits stream. This reduces the effect of inter-symbol interference (ISI) caused by multipath fading at OFDM receiver. Multipath fading occurs when a signal reflected from multiple paths from the transmitter to the receiver. Since any of these reflected paths will be longer than the direct path from transmitter to receiver, the multipath signals will be delayed relative to the direct path signal and will overlap with the next OFDM symbol. Since the OFDM symbol period is long, the amount of overlap can be small when compared with a serial modulation scheme where the amount of overlap can span several short symbols. Many popular standards and protocols now use some versions of OFDM. The usage of OFDM can be categorized into two sections, depending on channel, wireline or cable channel usage and wireless or air channel usage. Examples of wired channels usage are Asymmetric Digital Subscriber Line (ADSL) and Very-high-bit-rate digitalsubscriber line (VDSL)broadband access via Plain old telephone service (POTS) copper wiring, Digital Video Broadcasting – Cable-2, an enhanced version of the Digital Video Broadcasting Cable digital cable TV standard, Power line communication (PLC), ITU-T G.hn - a standard which provides high-speed localarea networking over existing home wiring (power lines, phone lines and coaxialcables), etc. There are many usages of OFDM in wireless communications. The wireless LAN (WLAN) protocol standardized by IEEE 802.11 and high performanceradio LAN-2 (HIPERLAN/2) which one is a European standard equivalent of IEEE 802.11 is defined by the European Telecommunications Standards Institute (ETSI) chose OFDM as radio interfaces.

III. PEAK TO AVERAGE POWER RATIO

OFDM is one of the many multicarrier modulation techniques, which provides high spectral efficiency, low implementation complexity, less vulnerability to echoes and non – linear distortion. Due to these advantages of the OFDM system, it is vastly used in various communication systems. But the major problem one faces while implementing this system is the high peak – to – average power ratio of this system. A large PAPR increases the complexity of the analog – to – digital and digital – to – analog converter and reduces the efficiency of the radio – frequency (RF) power amplifier .Regulatory and application constraints can be implemented to reduce the peak transmitted power which in turn reduces the range of multi carrier transmission. This leads to the prevention of spectral growth and the transmitter power amplifier is no longer confined to linear region in which it should operate.

This has a harmful effect on the battery lifetime. Thus in communication system, it is observed that all the potential benefits of multi carrier transmission can be out - weighed by a high PAPR value .

The major disadvantages of a high PAPR are

1. Increased complexity in the analog to digital and digital to analog converter.
2. Reduction is efficiency of RF amplifiers.

Let the data block of length *N* be represented by a vector X=[X_0, X1, Xn_{-1}]^T. Duration of any symbol Xkin the set ***X*** is *T* and represents one of the sub – carriers {FN, n=0, 1, 2…., N-1} set. As the *N* sub – carriers chosen to transmit the signal are orthogonal to each other, so we can havefn=n where n =1/NT and *NT* is the duration of the OFDM data block ***X***. The complex data block for the OFDM signal to be transmitted is given by,

$$x(t) = 1/\sqrt{n} \sum_{n=0}^{n-1} xn.\, e^{j2\pi n\Delta ft}, \quad 0 \le t \le NT,. \qquad \text{……(1.1)}$$

Now here is the explanation of PAPR in Mathematical equation form. PAPR is defined as the maximum power occurring in the OFDM transmission to the average power of the OFDM transmission. Mathematical representation has been given below.

PAPR:

The peak to average power ratio for a signal x(t) is defined as

$$papr = \frac{\max\left[x(t)x^*(t)\right]}{E\left[x(t)x^*(t)\right]}, \qquad \text{……(1.2)}$$

where $()^*$ corresponds to the conjugate operator.

Expressing in decibels,

$$papr_{dB} = 10\log_{10}(papr) \qquad \text{……(1.3)}$$

The PAPR of an oversampled version of *x* (*t*) calculated as per the above equation (1). Here in this equation our main goal is to minimize the max [$|X_n|^2$].

IV. CLASSIFICATION OF PAPR TECHNIQUES

Table 1 Classification of PAPR techniques

PAPR techniques	
Signal scrambling techniques	**Signal distortion techniques**
Block coding	Signal clipping
	Peak windowing
Sub block coding	Envelope scaling
Selective level mapping	Companding
Partial transmit sequence	
Interleaving	
Linear block coding	
Tone reservation	
Tone injection	

V. CLIPPING AND FILTERING

Clipping amplitude is stated as the simplest technique for PAPR reduction. Since the occurrence of very high peaks is rare, the clipping method can produce peak reduction as small cost of system degradation. Conventional error correction codes can offset such small degradation. Clipping is a non-linear operation therefore distorts the OFDMsignal. Note that, compared to the in-band distortion; the out-of-band radiation is more critical since it severely interferes with communications in adjacent frequency bands.Clipping and Filtering (CF) techniques eliminate the out-of-band radiation by clippingthe time-domain signal to a predefined level and subsequently filtering it. The relativelysmall in-band distortion is combated using low-order signal constellation, coding, and/or clipping noise cancellation techniques.Though the out-of-band radiation is reduced by filtering, makes peaks to re-growth. Iterative clipping and filtering works in recursive fashion until target PAPR is obtained. Later its modified version such as Simplified Clipping and Filtering and One Iteration Clipping and Filtering schemes are shown to be less computation intensive. One iteration technique obtains the same PAPR reduction as that of the previous Iterative Clipping and Filtering (ICF) technique with several iterations. The computational complexity is, therefore, significantly reduced. The simplified, one iterative, technique has better PAPR reduction and out-of-band radiation than Iterative Clipping and Filtering (ICF) technique. But Bit Error rate (BER) performance is better of Iterative Clipping and Filtering (ICF) technique than one Iterative Clipping and Filtering. In terms of out-of-band radiation and BER, the simplified, one iterative, technique performs similar to ICF in deep clipping cases.Clipping noise mitigation for performance improvement is also possible. Theeffectiveness of clipping and filtering method has been assessed recently based on total degradation (TD) and results showed that it degrades rather than improves the systemperformance, although the degradation is small for high clipping thresholds than low-clipping

thresholds.

Table 2 Overall Analysis of Different Techniques

Name of Schemes	**Name of parameters**		
	Distortion Less	Power Increases	Data rate loss
Clipping and Filtering	No	No	No
Coding	Yes	No	Yes
Partial Transmit Sequence(PTS)	Yes	No	Yes
Selective Mapping (SLM)	Yes	No	Yes
Interleaving	Yes	No	Yes
Tone Reservation (TR)	Yes	Yes	Yes
Tone Injection(TI)	Yes	Yes	No

VI. SIMULATION& RESULT

Clipping & Filtering

High PAPR is one of the most common problems in OFDM. A high PAPR brings disadvantages like increased complexity of the ADC and DAC and also reduced efficiency of radio frequency (RF) power amplifier. Clipping & Filtering techniques is mostly effective techniques to reduce the high PAPR in OFDM system. Here clipping is the nonlinear processes which increase the band noise distortion, also increase in the bit error rate also decrease the spectral efficiency. Here using with filtering this techniques will give better performance. Filtering after clipping will reduce out of band radiation. This technique will reduce the PAPR without spectrum expansion. Here if the OFDM signal is over sampled then the scheme of correction is suitable with the clipping so that each subcarrier generated with the interference. So for proposed this scheme each signal must be oversampled by factor of four. This scheme is more compatible with the PSK modulation scheme.

As per the technique above fig RESULT 1 shows the previous simulation by keeping CR= 3.5, that is due reduction in the PAPR can be done up to 5.69dB only but the times always wants some changes so by this technique due to some changes better result can be display.

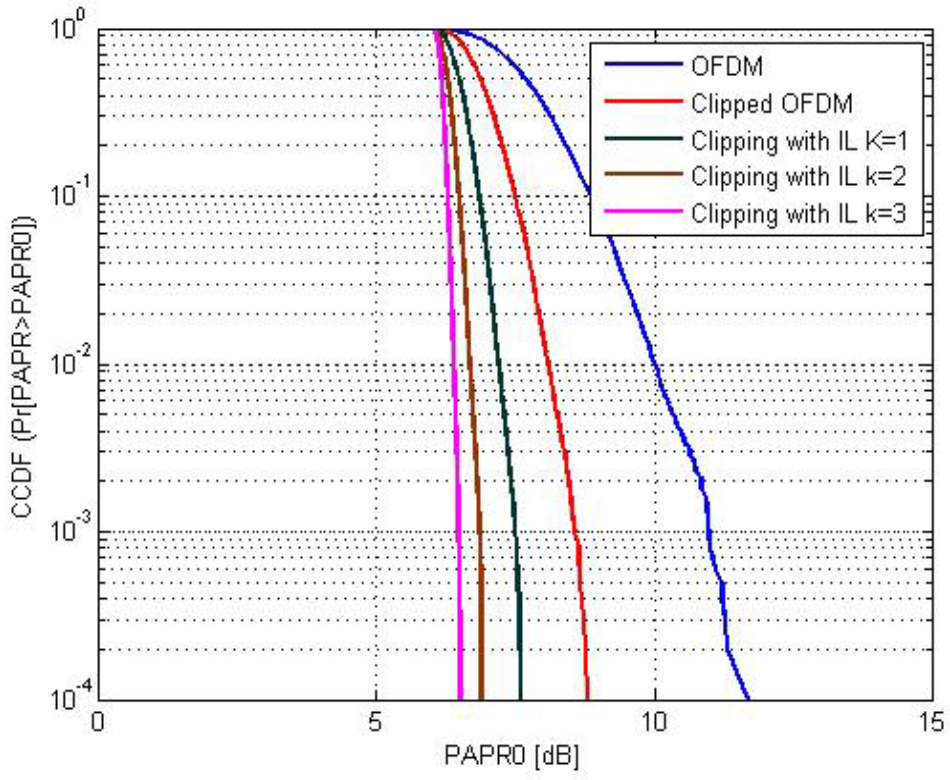

Fig 1 RESULT-1

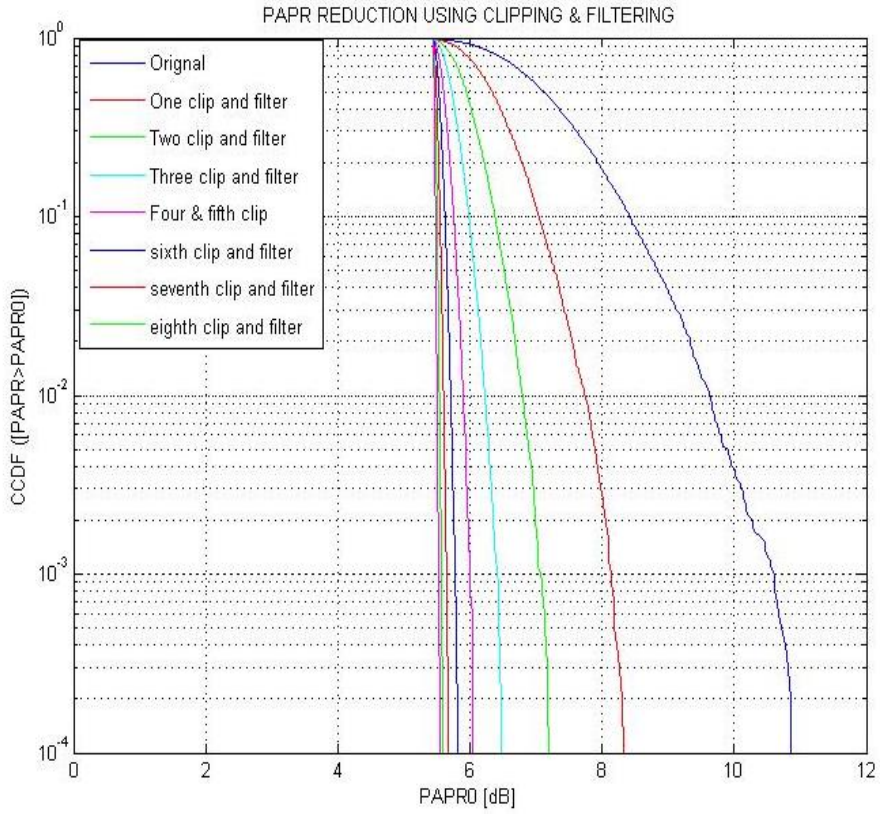

Fig 1 RESULT-2

Table-3 Data of Reduction in CCDF for 128 OF RESULT 2

Clipping	Power in dB	Difference in Db
Original	11.26	
1	8.56	2.7
2	7.283	1.277
3	6.504	0.779
4	6.059	0.445
5	6.00	0.059
6	5.806	0.194
7	5.657	0.149
8	5.569	0.088

VII. CONCLUSION AND FUTURE EXPANSION

As now as per the overall research it is clear that for the use of OFDM (Orthogonal Frequency Division Multiplexing) for the high data rate transmission we have to consider its disadvantage and try to reduce it. So here our concentration is on PAPR (Peak to Average Power Ratio). So to reduce it many techniques have been proposed and I have used clipping and filtering technique. after simulation of these techniques the better result can be achieved to reduce the PAPR problem in OFDM system so this simulation can be helpful for the efficient transmission of the OFDM system. We also conclude that by simulate each technique in different modulation like BPSK & QPSK. In future by improving these technique to Reduce PAPR in OFDM system and improving also in OFDM system better technology can be provide to the Society.

REFERENCES

[1] R. O"Neil, L. B. Lopes, "Envelope Variations and Spectral Splatter in Clipped Multicarrier Signals", Proc. IEEE PIMRC '95, Toronto, Canada, September 1995.
[2] X. Li, L. J. Cimini, Jr., "Effect of Clipping and Filtering on the Performance of OFDM", IEEE Commun. Lett., Vol. 2, No. 5, May 1998.
[3] J. Armstrong, "Peak – to – Average Power Reduction for OFDM by Repeated Clipping and Frequency Domain Filtering", Elect. Lett., Vol. 38, No. 8, February 2002.
[4] S. H. Muller, J. B. Huber, "A Comparison of Peak Power Reduction Schemes for OFDM", Proc. IEEE GLOBECOM '97, Phoenix, AZ, November 1997.
[5] R. W. Baumi, R. F. H. Fisher, J. B. Huber, "Reducing the Peak – to – Average Power Ratio of Multicarrier Modulation by

Selected Mapping", Elect. Lett., Vol. 32, No. 22, October 1996.
[6] V. Vijayarangan, Dr. (Mrs) R. Sukanesh , "An Overview Of Techniques For Reducing Peakto Average Power Ratio And Its Selection Criteria For Orthogonal Frequency Divisionmultiplexing Radio Systems" Journal Of Theoretical And Applied Information Technology,Year 2009 ,Vol-5, No-5, E- Issn- 1817- 3195/Issn-1992-8645
[7] Natalia Revuelto, "PAPR reduction in OFDM systems", year 2008, Master thesis, Universitat polytechnic De catalunya.