IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-5, Issue-10 E-ISSN: 2347-2693

An Approach to Improve the Quality of OFDM Signal Using Papr Reduction Schemes

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Available online at: www.ijcseonline.org

Received: 09/Sep/2017, Revised: 25/Sep/2017, Accepted: 14/Oct/2017, Published: 30/Oct/2017

***Abstract*—** Orthogonal-frequency division-multiplexing(OFDM) is a standout amongst many commended different access framework, which is capable of performing both modulation and multiplexing in both wired and wireless communication specially used to achieve the today"s need of high speed communication beyond 4g-Long term evolution. OFDM was originally adapted by 3GPP association for the development of LTE. It has many advantageous characteristics such as higher spectral efficiency, higher bit rate, and lower multipath distortion etc. Even with these many advantages OFDM still suffers from few critical issues. One among them is OFDM signal"s higher peak power ratio (PAPR). Which drives power amplifier into a nonlinear region hence results toout of band radiation and in band distortion which is a reason for degradation of performanceof the system in terms ofBER. Here we will demonstrate the reenactment of the OFDM with various supporting adjustment systems, for example: QPSK, QAM. Additionally, here will demonstrate an endeavor to decrease the PAPR utilizing distinctive PAPR lessening procedures to enhance the nature of the OFDM signal along withsimulation results.

***Keywords*—** OFDM, PAPR, LTE and QAM.

I. INTRODUCTION

From the past few years, there is rapid progress in the region of communication that includes both wired and wireless communication fields. Even though the technology is developing rapidly day by day the need for high speed communication goes on increasing. Also it is desirable provide service to in terms of speed of operation, data rate and the concept of providing service to more consumer within a stipulated band of frequency. There has been a lot of research work to cope up these requirements, both in case of regulation plans like ASK, PSK, FSK, or access plans like FDMA, TDMA, CDMA. Stating from Ist generation till IIIrd generation, whatever the traditional techniques we are using they are not able to reach the actual deadline. Researchers have found one such access technology that can perform both modulation as well as multiplexing and that can fulfil the needs of high speed communication, which can provide higher data rate and more it provides service to the more number of users within an allocated bandwidth that results in higher spectral efficiency that technology is termed as Orthogonal Frequency Division Multiplexing.

Among the various multiple access schemes the most popular one is OFDM which performs effective modulation by means of Inverse Fourier transforms and multiplexing of subcarriers. The objective is to provide high speed communication in the era of smartphones by supporting its needs which was originally adapted by 3GPP-LTE in order to provide services beyond 4G. OFDM is popular because of its advantageous characteristics such as higher spectral efficiency, high speed data rate, mitigated delay spread, resilience to radio frequency interference, and lesser distortion in multipath propagation of signal. Disadvantage of the system is synchronism accuracy. OFDM has wide range of applications that includes digital broadcasting of audio signals, higher quality video broadcasting, HDTV, WiMAX, IEEE 802.11a/n/g wireless ATM transmission systems, wireless LAN, cellular phones etc. even though there are many advantages, OFDM still suffers from critical problems associated with the OFDM system. One of them is "Peak to Average Power Ratio". This arises due to extreme shoot in the amplitude of OFDM signal which causes the power amplifier of the system to drive in nonlinear region. In nonlinear region, operationof the power amplifier requires more power which degrades the system"s performance. It is very essential reduce the PAPR, so as to maintain the operation of power amplifier in the linear region. There are many ongoing researches in order to minimize the higher shoot in the "Peak to average power ratio in OFDM signal by the usage of available PAPR reduction techniques. The PAPR removal schemes can be categorized into two major types depending upon the operation which they can perform on the OFDM signal. Signal scrambling procedures and signal distortion methods are two noteworthy orders under which we can see SLM, PTS, interleaved OFDM, clipping and filtering, tone rejection, tone infusion or injection, companding, CMA individually. In this the analysis of OFDM has been done, various advantages, disadvantages and applications has been discussed. Chapter one gives the

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brief overview of the overall project. Chapter two focused on OFDM it addresses the topic such as history of OFDM, background of OFDM, basic principle of OFDM, orthogonality and its need, modulation techniques used by OFDM such as and QPSK and QAM, modulation and demodulation process by using IFFT/FFT, and finally cyclic prefix used in symbols of OFDM. And a summary of previous works has been discussed in the chapter three, chapter four focuses on different PAPR reduction techniques. The simulation results and observations are provided in chapter five highlights the conclusion and work frequency can be done in future. Prior to OFDM there existed parallel transmission of data streamsby the use ofmultiplexing technique called "frequency divisionmultiplexing (FDM). Itwas published in middle of 60[1, 2]." Few early developments dates back to50s. So Data streams, with sub channel overlapping in order to reduce the usage of high speed equalization and to suppress the impulse noise, and distortion in multipath propagation also to increase the spectrum efficiency. Initially, major applications were developed for military communications. In the field of information transfers, the terms, for example: discretemulti-tone (DMT), multi-channel adjustmentand multi carriermodulation (MCM) are utilized broadly and relying on the application they can be traded with. All the sub bearers are orthogonal to each other. In any case, the orthogonality is not generally kept up in MCM. We call is as a streamlined type of multicarrier transmission plans.

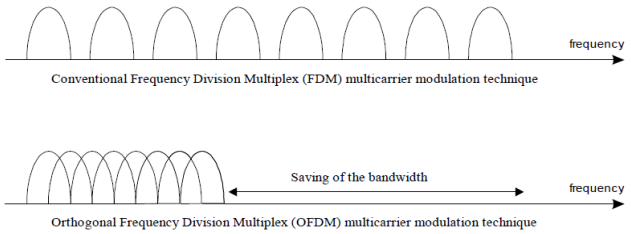

Fig 1.1 Utilization of bandwidth Comparison for FDM andOFDM

The utilization of a generally vast number of subcarriers with limited groups. Interestingly, a direct multi-transporter plan expansion as depicted in Figure 4 would regularly comprising of just few number of subcarriers, each with a generally more extensive transfer speed. Consider an illustration, a development of WCDMA multi-bearer with general transmission transfer speed restricted to 20MHzcould comprises of four (sub) transporters, every bearer is doled out with a data transfer capacity of 5 MHz In examination, by the utilization of OFDM transmission a few hundred subcarriers can be sent over the ordinary radio association with the same authority.

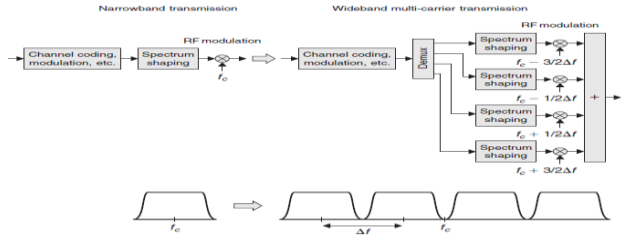

Figure 2 Single Carrier transmission in terms of multicarrier transmission.

NEEDS OF ORTHOGONALITY

There are many benefits of using orthogonality between OFDM subcarriers which are as listed below.

First reason for using orthogonality is that, It Provides better separation among the sub carriers resultantly it provides effective utilization of spectrum resultantly higher spectrum efficiency. Need of steep band pass filter is eliminated. Provides Effective randomization of burst errors is possible which are caused due to the fading. Adjacentlyspaced several symbols Distortion is avoided. Successful reconstruction of distorted symbol is possible without even using FEC.

ADVANTAGES OF OFDM

"OFDM has a few preferences over single transporter balance frameworks and these make it a feasible option for CDMA in future remote systems. In this segment, we will examine some of these focal points".

Multipathdelay spread resistance: OFDM is exceedingly invulnerable to multipathdelay spread that origins between image impedance in remote channels. Since the image length is prepared bigger (by changing over a high information speed signal into N low speed flags), the impact of deferralspread is lessened by the similar element. Likewise by presenting the ideas of gatekeeper timeand cyclic expansion, the impacts of between image impedance (ISI)and between transporter obstructions (ICI) can be evacuated totally.

The paper is organized as follows: in section II Review of literature is describe, then in section III proposed work is discussed, in Section IV Simulation and results is presented and Conclusion is presented in Section V.

II. REVIEW OF LITERATURE

In 2015, MamtaBishtandAlok Joshi have been examined around a non-steady envelope with high crests in "Orthogonal Frequency Division Multipletxing (OFDM) signal which is a noteworthy detriment of the framework. Also, expressed that these high tops produce signal outings into non-direct locale ofoperation of the Power Amplifier (PA) at the transmitter. Different Peak to Average Power Ration (PAPR) diminishments, for example, SLM, PTS, Peak windowing, companding, tone reservation, tone infusion, pre-coding, square coding systems techniques have been proposed in the writing.

In Sep 2015 NutanKumari, Simarpreet Kaur contemplated the idea of OFDM framework expresses that it is a type of multi-bearer tweak. The OFDM framework experiences the downside of high PAPR i.e. Top to normal Power Ratio. Various Techniques, for example, SLM, PTS, Tone Reservation, Clipping and sifting and so on have been talked about which are utilized to diminish the PAPR impact in OFDM frameworks. Distinctive parameters, for example, contortion Rate, information rate, power raise and so forth are dissected with the investigation of various PAPR decrease strategies.

In Oct 2015, Rimpidatta, anirbanbhar, arpita barman santra, sohanghorai have done the study on the ofdm and portrayed the issue Peak to normal force proportion connected with

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the framework and proposed the relative investigations of PAPR diminishment systems, for example, specific mapping, cutting and sifting and tone reservation strategies with unreduced PAPR.

In July, 2012 Gagandeep Kaur, Rajbir Kaur considering"Multicarrier CodeDivision Multiple Access (MC-CDMA)"is the most encouraging procedure for fast information transmission. Be that as it may, the MC-CDMA signs are described by extensive crest to-normal force proportions (PAPR), which can diminish the framework proficiency. Talked about SLM and PTS systems are researched and their exhibitions are looked at. The execution metric used in assessing PAPR diminishment plan is CCDF of the PAPR of transmitted nonstop time signal. With the assistance of MATLAB recreation it has been found that PTS has preferred PAPR decrease ability over SLM plan.

In 2013, Mangalasingh, saratkumarpatra demonstrated that "Orthogonal Frequency Division Multiplexing (OFDM) is"a standout amongst the most encouraging method for now's remote broadband correspondence frameworks. 3GPP's LTE was the first to embrace OFDM as its downlink system. One of the significant hindrances is its high crest to-normal force. In dec 2015, Yaminilakhanpal and mandeepsinghsaini recommended that orthogonal recurrence division multiplexing (OFDM) is the effective multiplexing and tweak strategy adjusted for 4G remote correspondence applications. OFDM is fast information transmission plan in remote correspondence. The one of the fundamental burden of the OFDM is crest to normal force proportion PAPR. Predominantly, due to non-linearity of high power speaker, these outcomes intercarrier obstruction and debasement of bit mistake rate (BER). OFDM comprise of vast number of free sub transporters as a consequence of which sufficiency of such flag have high values. In any case, as the quantity of sub transporter's build PAPR likewise increments. The diverse PAPR diminishment strategies are accessible, for example, Clipping, Companding, Selective Mapping (SLM), Tone Injection (TI), Tone Rejection (TR) and Partial Transmit Sequence (PTS). In this paper, another methodology is proposed in which cross breed procedures are utilized incomplete transmit succession (PTS), sifting and companding. Crest to-normal force proportion of transmission sign because of the superposition of numerous subcarriers. This paper introduces another half and half crest to normal force proportion lessening system, which consolidates a particular mapping strategy with the section technique. The paper displays the execution and focal points of the new system and contrasts it and other existing strategies.

In May 2014, MohamedZahra, Ibrahim F. Tarrad and MohamedMounir have recommended that Multiple-InputMultiple-Output Orthogonal FrequencyDivision Multiplexing (MIMO-OFDM) is a key contender for 4G broadband remote correspondences. Be that as it may, "MIMO-OFDM" acquired the issue of high "Peak-to-AveragePower Ratio (PAPR)" from OFDM. Numerous PAPR lessening systems were created in most recent two decades to diminish the PAPR under OFDM, among them PartialTransmitSequence (PTS) and SelectedMapping (SLM) demonstrate an exceptionally effective PAPR decrease execution. In writing there are three surely understood methodologies for stretching out SLM-PTS to MIMO-OFDM specifically customary (oSLM/oPTS), rearranged (sSLM/sPTS), and coordinated (dSLM/dPTS). Half and half SLM-PTS procedures consolidate SLM & PTS in four distinctive approaches to re duce the required Half and half SLM-PTS procedures consolidate SLMand PTS in four distinctive approaches to reduce the essential computational intricacy lesser than both SLM as well as PTS. They demonstrated the execution of applying standard and improved methodologies on the HybridSLM-PTS strategies in MIMO and OFDM framework. Additionally, Investigated the likelihood of applying guided way to deal with HybridSLMPTS procedures by method for proposed approach that joining dSLM&dPTS in another methodology.

The primary impediment of OFDM framework is high "Peak to Average Power Ratio (PAPR)". So to accomplish low PAPR, there is a need to apply a successful strategy on these frameworks. An adjusted methodology is connected for the lessening of PAPR under OFDM frameworks are Tone Reservation, Partial Transmit Sequence and Companding.

III. PROPOSED WORK.

3.1 Concept of PAPR.

PAPR ismaximum shoot in the amplitude of signal to its average value this reduces the efficiency in Radio Frequency by driving power amplifiertowards non saturation area. This is a major problem in OFDM. The PAPR can be given as shown in below expression.

$$\mathrm{PAPR}(x)=\frac{\max|x(t)|^2}{E[|x(t)|^2]}$$

Where *E* [.] indicates the expectation operator.

X (t)-OFDM signal occurs in a system where multicarrier are used which are outside phase with each other, they are dissimilar to each one at every instant at different phase units. When all the carriers reaches same value simultaneously then a shoot will occur in the output signal that we call as peak value. As compared to the average value of the signal the value of peak signals can be very high. This ratio of peak to averagepower value we term as peak to averagepower ratio, the problem of PAPR drives power amplifier towards non saturation area this causes the degradation in performance of the system in case of BER. We can see the characteristic curve of HPA as shown in Figure 3.1.

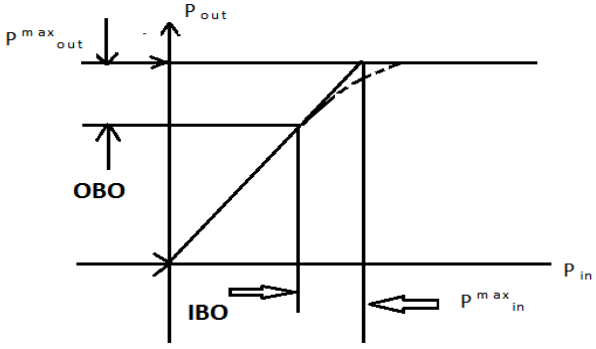

Fig 3.1 Characteristic curve of HPA

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3.2 MINIMIZATION SCHEMES OF PAPR

The reductions techniques are mainly classified as signal scrambling, signal distortion and coding techniques. The available reduction techniques SLM, PTS and interleaved OFDM are under signal scrambling techniques and peak windowing; clipping and filtering, tone rejection, tone injection, companding under signal distortion techniques. Many coding techniques such as block coding or pre-coding, Hadamard code hamming code, etc.

3.2.1 SIGNAL SCRAMBLING TECHNIQUES: The most used techniques and basic concept behind the techniques is, it select the series of signals with minimum PAPR price the methods come under this category are SLM, PTS and InterleavedOFDM.

3.2.1. A) SELECTED MAPPING TECHNIQUE (SLM): This is scrambling technique in which a stream of signal are transmitted with indication of some information in each signal. Among the transmitted signals a sequence of signal with very minimum PAPR value is scrambled and transmitted above the channel. The carefully chosen signals information must be directed to the receiver along with carefully chosen signal as signal side information(SSI) in order to decode the original information at the receiver. Suppose if there is any mistake or error in the sent side information then it is very difficult to receive signal at receiver. The side information to be transmitted should have protection to receiver original signal along with selected signal. Once the receiver has been received this side information then decoding of the transmitted signal becomes easy. Fig. 3.2 depicts the blockdiagram of SLM technique.

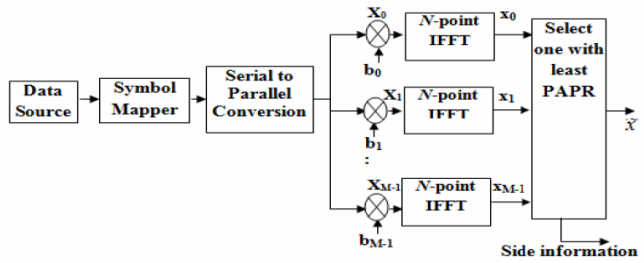

Fig 3.2 Block diagram of selected mapping

3.2.1. B) PARTIAL TRANSMITS SEQUENCE (PTS): The PTS technique is most commonly used technique used in decrease of PAPR. The concept of PTS Scheme can be understood by looking at its bock diagram this is as depicted in Figure 3.3.

The knowledge behind the PTS system is that it divides the main sequences of OFDM into several sequences and enlarges each sequence by distinct weights till we get the best results. The PTS block Diagram shows that the N symbols inputdata block is portioned into many alternate subblocks and then information sequences are further transmitted. The portioning of sub-blocks is one another factor, as it also affects the PAPR reduction performance which should be taken into consideration. Sub blocks can be partitioned in three ways as adjacent, interleaved and pseudo-random portioning. Due to use of more number of sub-blocks so this requires more IFFT for computation this drives the system into complexity. Along with this it also adds SII (Side Information Index) as that in SLM scheme. That is also concern for system to take care of SSI that should be sent to receiver for decoding of information.

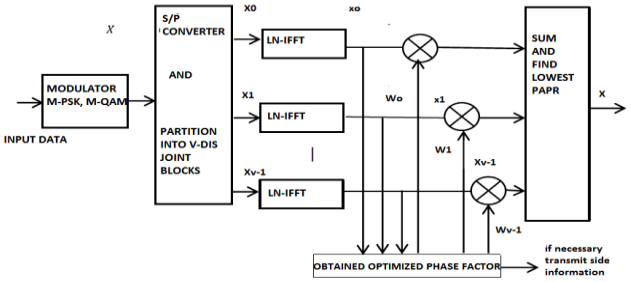

Fig 3.3 Block diagram of Partial Transmit sequence

3.2.1. C) INTERLEAVED OFDM: It is like alternate method of SLM, just the difference is that it uses an inter-leaver as a substitute of using the sequences of phases. Interleaver is a computationaldevice which has definite manner permutation and operates on N-symbols block. The interleavedOFDMs block diagram is as shown in Figure 4.4. π and π-1 symbols are used to denote inter-leavers and de-inter-leavers.

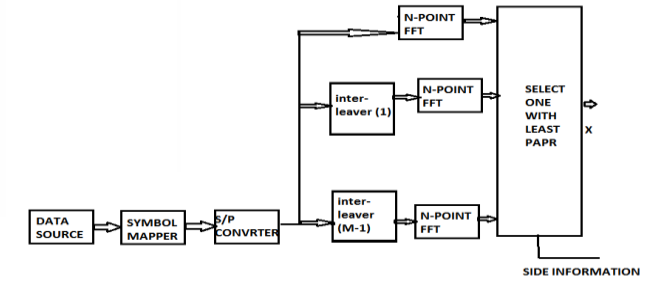

Fig 3.4 Block diagram of Interleaved OFDM

3.2.2 SIGNAL DISTORTION TECHNIQUES: Thereare different types of that comes under signaldistortion method. The idea behind these technique is that it distorts the originalOFDM signal non linearity.

3.2.2. A) CLIP AND FILTER METHOD: One of the very simple approach for PAPR reductionin OFDM signal is clip and filtermethod is listed under the classification if signal distortion techniques. The technique uses a predefined threshold value

$$x_c[n] = \begin{cases} -A & x[n] \le -A \\ x[n] & |x[n]| < A \\ A & x[n] > A \end{cases}$$

Where A=pre-defined threshold value.
x[n]=pass band OFDM signal.
xc[n]-clipped version of x[n].
With reference to the threshold it clips the amplitude peaks of the original OFDM signal. There may be reduction in PAPR of signal but there is chance of losing original

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information associated with the signal. Also it introduces and using filtering we may able to avoid the out of band radiation but filtering causes re-generation of peaks.

3.2.2. B) TONE RESERVATION: It is a reservation method to reduce the. And this method uses some reserved tones and also some carriers are needed to be reserved in order to remove the. The selected subcarriers should be capable of reducing the PAPR of OFDM frame size. The complexity associated with this method is that it should have reserved tones in large numbers so as to reduce PAPR efficiently otherwise reduction in PAPR represents non negligible samples of available bandwidth. The merit of tone reservation technique is that is needs no processing and side information at the receiver.

3.2.2. C) TONE INJECTION: With the use of this method the PAPR of multicarrier signal can be reduced efficiently without loss of data rate. In order to minimize the PAPR this method uses a set of equivalent constellation points which are being used by tone injection approach for original constellation points. The technique suffers from increased complexity due to requirement of additional IFFT operation; it also needs additional side information at the receiver for decoding process.

3.3 CONSTANT MODULUS ALGORITHM (CMA): Constant modulusalgorithm is efficient scheme to reduce PAPR. Though the reduction of PAPR is not possible 100 percent but it can be gradually reduced up to 90 percent by using CMA with the help of two different algorithms such as SD-CMA (steepest decent-CMA) and UC-CMA (unit circle-CMA). We reduce PAPR using CMA in multiple steps as first step timedomain signals generating from resourceblocks are linearly combined with 'pre-coding weights' with transmission of side information to the receiver. In next steppre-coding weights obtained are designed in such a way that amplitude variation of the resulting signal is minimized, which results in reduced PAPR

IV. SIMULATION AND RESULTS

4.1 BER performance Comparison of OFDM signal with different modulation schemes

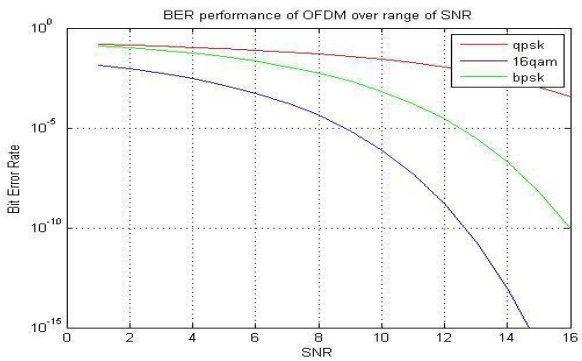

Fig. 4.1 BER performances of OFDM versus SNR.

Performance comparison of BER of the signal using three different modulationschemes such as BPSK, QPSK, and 16QAM are as shown in figure 4.1 for the 16 number of transmitted symbols (power of 2). In which the graph curve with green, blue, and red color indicates the BER performance obtained by plotting the graphs of BER versus SNR.

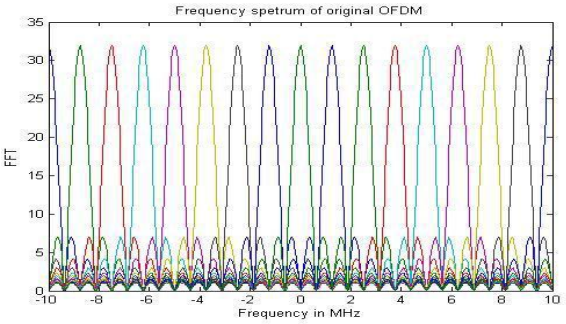

Fig 4.2 spectrum of original OFDM

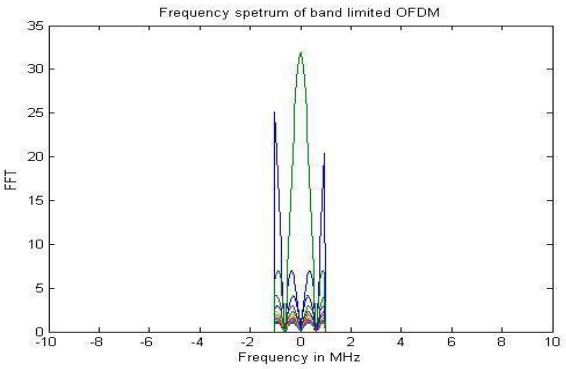

Fig 4.3 Spectrum of band limited OFDM

Figure 4.2 and 4.3 shows the frequency spectrum of OFDM signal for the given frequency range 20 MHz with a cut off frequency of 2 MHz there will be 16 carriers for shown output.

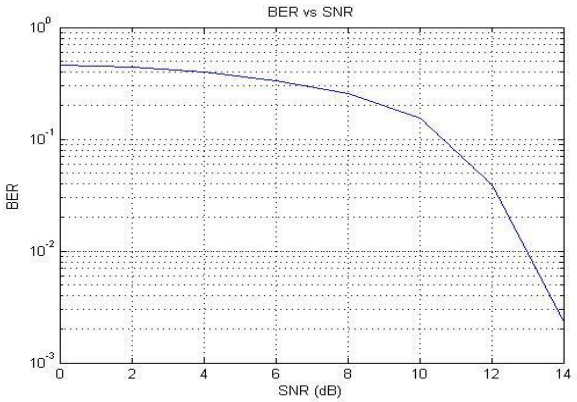

Fig 4.4 BER versus SNR of OFDM

The analysis of Bit errorrate(BER) is done by considering the Signal to noiseratio which is simulated as shown in figure 4.4. The simulation shows that as the SNR increases BER reduces.

4.2 PAPR REDUCTION USING SLM TECHNQUE

The figure 4.5 shows the simulation results of SLM, a PAPR reduction technique for the given input data values as below.

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For number of transmitted symbols64 and the for alphabet size16 we obtain the result of PAPR of SLM modified OFDM as 16.3849 wherein the PAPR of normal OFDM is 21.2378.

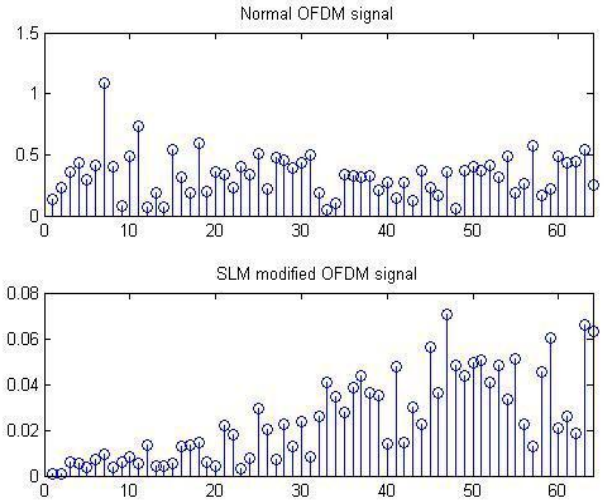

Fig 4.5 PAPR reduction using SLM

4.3 PAPR REDUCTION USING CLIP AND FILTER METHOD

The simulation result shown below in figure 4.6 shows the OFDM signal generated using clipping and filtering method. For the given input data values below

For the L factor (1 to 1.5) of 1

For the number of transmitted symbols(Power of 2) (preferably>32)of 64

For the alphabet dimension(Power of 2 and lessthan number of Symbols)(preferably<32)of 16

The comparative PAPR values of Original signal and the signal generated using clipping and filtering method are as below.

PAPR of original OFDM4.5000where as the PAPR of clipped OFDM is 2.9681 so the peak power value is reduced by value 1.54.

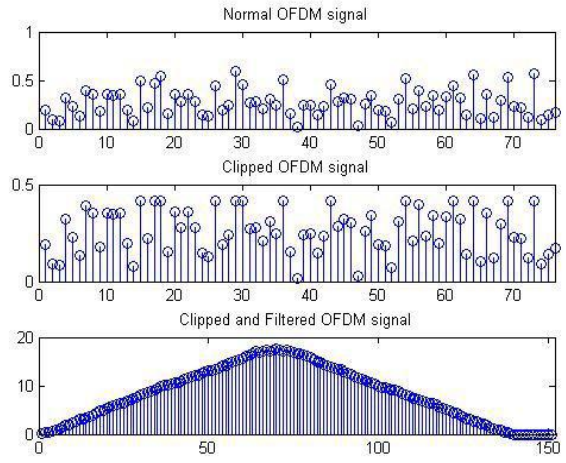

Fig. 4.6 PAPRreduction using clipping & filtering

4.4 PAPR REDUCTION-USING TONE RESERVATION TECHNIQUE

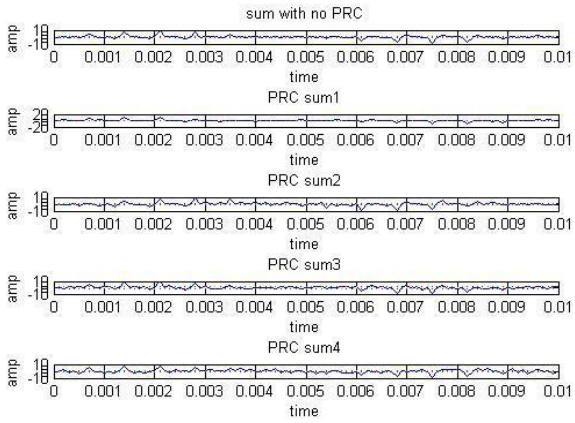

Fig 4.7 PAPR reduction using Tone reservation

V. CONCLUSIONS.

After examining all about OFDM and the problems associated with the OFDM technique, we come to the conclusion that even though ofdm can provide better spectral efficiency, better immunity to interference, carrier frequency offset of still it suffers from peak power problem which can be overcome by using several PAPR reduction techniques as demonstrated in previous chapters. After studying all the PAPR reduction techniques, it is concluded that almost all the techniques which are classified as signal scrambling and signal distortion techniques can reduce the PAPR effectively, but signal scrambling techniques are most widely used, because the signal distortion techniques disturbs the original property of transmitted signal, which may destroy the actual data to be transmitted. Hence signal scrambling techniques, particularly the partial transmission technique is found to be better one for the removal of PAPR which can remove the PAPR to a higher extent.

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