ZCT Precoded SLM Technique for PAPR Reduction in OFDM Systems using various Modulation Techniques

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(*April* 2015)

CERTIFICATE

This is to certify that the Dissertation-II titled "ZCT Precoded SLM Technique for PAPR Reduction in OFDM Systems using various modulation techniques " that is being submitted by Savindervir Singh in partial fulfillment of the requirements for the award of MASTER OF TECHNOLOGY, is a record of bonafide work done under my guidance. The contents of this Dissertation-I, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

Mr. Surjeet Kumar
(Assistant Professor)
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Objective of the Disertation-II is satisfactory / unsatisfactory

Examiner I

Examiner II

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Place: LPU, Jalandhar — Savindervir Singh

Date: April, 2015 — Reg.No: 11306077

DECLARATION

I hereby certify that the work, which is being presented in the report, entitled A Study on PAPR in the OFDM Systems, in partial fulfilment of the requirement for the award of the Degree of Master of Technology and submitted to the Department of Electronics and communication Engineering of Lovely Professional University, Punjab, institution is an authentic record of my own work carried out during the period December-2014 to April-2015 under the supervision of Mr Surjeet Kumar. I also cited the reference about the text(s)/figure(s)/table(s) from where they have been taken.

The matter presented in this thesis as not been submitted elsewhere for the award of any other degree of diploma from any Institutions.

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ABSTRACT

Orthogonal frequency division multiplexing (OFDM) is perhaps the most spectrally efficient, robust transmission technique discovered so far for communication systems,
And it also mitigates the problem of multipath environment. High peak-to-average power ratio (PAPR) has always been a major drawback of the OFDM systems. In this article, a new precoding technique has been proposed based on Zadoff-Chu Matrix Transform (ZCT) and selective mapping (SLM) to reduce PAPR in OFDM systems. ZCT precoding having optimum correlation properties and having an ideal periodic autocorrelation and constant magnitude and thus reduces the autocorrelation of the input sequences while SLM takes an advantage of the fact that the PAPR is very sensitive to phase shifts of the signal. The main advantage of this proposed scheme is to achieve a significant reduction in PAPR without increasing the system complexity. Matlab simulations show that, the proposed method outperforms the existing precoding techniques without degrading the performance of the system.

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LIST OF ABBREVIATIONS

AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary phase shift keying
CSI	Channel Side Information
FFT	Fast Fourier Transform
FCC	Federal Communications Commission
GSM	Global System for Mobile communications
ICI	Inter Carrier Interference
IEEE	Institute of Electrical and Electronics Engineers
IFFT	Inverse Fast Fourier Transform
ISI	Inter Symbol Interference
OFDM	Orthogonal Frequency Division Multiplexing
PAPR	Peak to Average Power Ratio
SNR	Signal to Noise Ratio
SINR	Signal to Interference plus Noise Ratio
WiMax	Worldwide Interoperability for Microwave access

Chapter 1

INTRODUCTION

1.1 Introduction

Orthogonal frequency division multiplexing (OFDM) is a key technology for the present and future broadband wireless communication systems. OFDM is a technique in which digital data is encoded on carrier frequencies which are multiple in numbers.OFDM is broadband multicarrier modulation methods that have better-quality performance and profit over conventional modulation methods which are single-carrier because it is a superior fit with latest rapid data necessities along with action in the UHF plus microwave spectrum.

In OFDM, the sub-carrier frequencies are selected with the intention that they perpendicular towards every carrier, means so as to remove cross- talk among the adjacent-channels along with inter-carrier guard bands must not be required. By doing this structure of transmitter along with receiver is very much simplified. OFDM need to use very precise frequency organization involving the receiver and the transmitter; by means of frequency digression the carriers having additional information will be parallel, leads to inter carrier interference (ICI) (i.e., cross- talk among sub- carriers).We possibly will add cognitive radio under OFDM.

1.2 Principles of OFDM

The Block Diagram of OFDM shown in figure1.1. Frequency Division Multiplexing (FDM) is a method where the central signal supposed to send must be fragmented to non-dependent signals, we may call it as subcarriers inside the regularity field. Thus, the original information stream is divided into numerous equivalent streams (or channels), one for each subcarrier. After that every subcarrier must required to modulate by conventional modulation

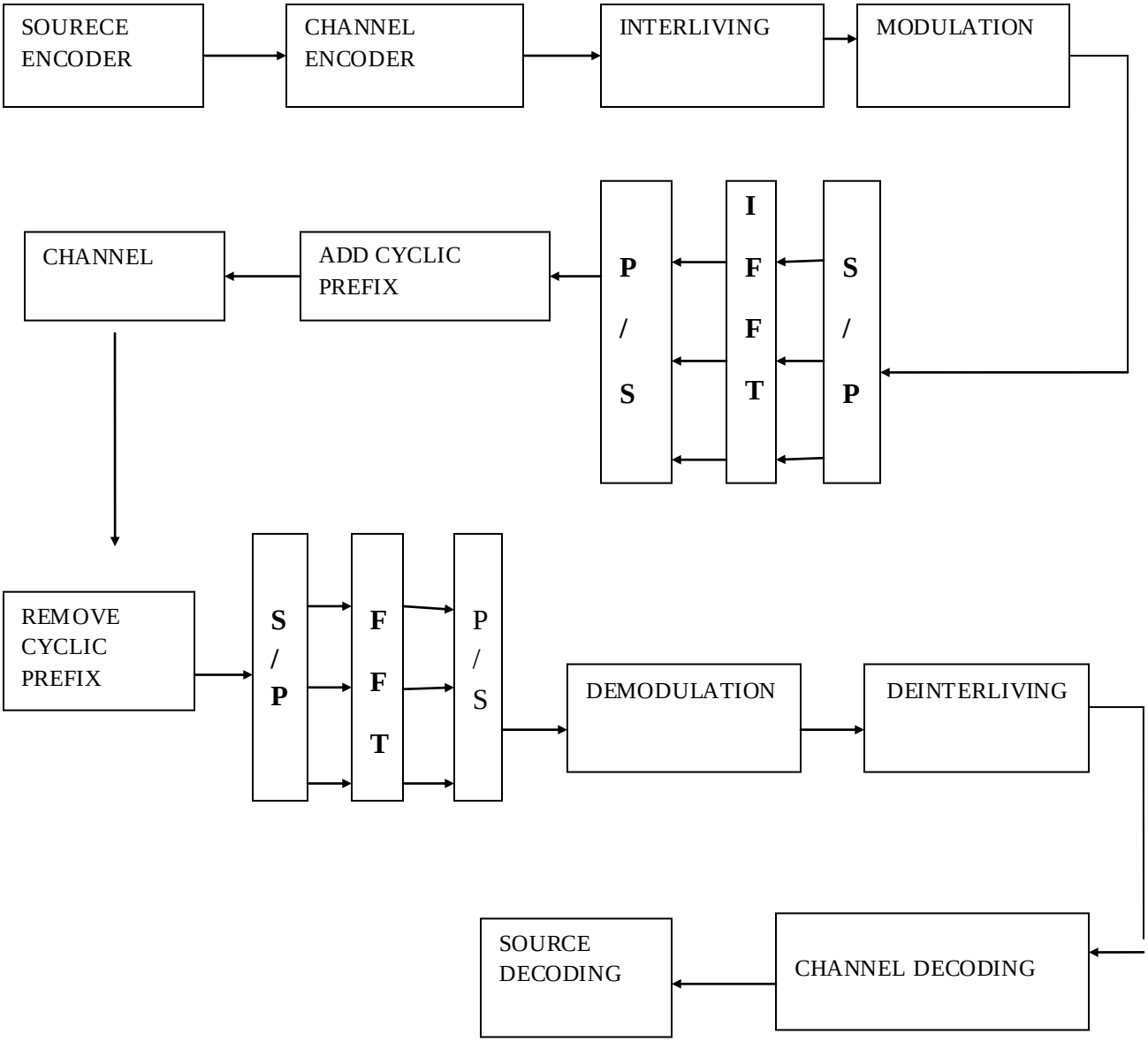

Figure 1.1: OFDM block diagram

Plan moreover combined mutually just before produce the FDM signal. In an FDM transmission, the receiver needs to be able to independently recover each of the subcarriers and therefore these signals need to fulfill certain conditions. For instance, they can have non overlapping spectra so that a bank of filters tuned to each of the different subcarriers can recover each of them independently. However, practical filters require guard bands between the subcarrier bands and therefore the resulting spectral efficiency is low. If the subcarrier

signals fulfill the orthogonal condition, their spectrum can overlap, improving the spectral efficiency. This technique is known as orthogonal FDM or OFDM.

Suppose that each small truck uses a different road, where every available path has the same length and all the trucks drive at the same speed. If an accident happens in one of the roads and it gets blocked, part of the packets will be received at the destination. On the other hand, if all the packets are transported by a big truck that drives on the same road where the accident happens, the whole shipment will get stuck and will not arrive to destination. For an OFDM signal transmission, each small truck represents a subcarrier, and the roads where data is going to be carried are an analogy of the different frequencies at which each subcarrier is going to be transmitted. Moreover, each packet containing goods represents the modulated portion of data to be carried by a subcarrier, which is called an information symbol.

FFT Logic: A fast Fourier transform is an efficient algorithm to compute the discrete Fourier transform (DFT) and it's inverse. This is applied to discrete data so the transforms are done by summing instead of integration. The Fast Fourier Transform is a representation used in computer codes.

The DFT is defined by the formula:

$$X[k] = \sum_{n=0}^{N-1} x[n] e^{-\frac{i2\pi kn}{N}}; \quad 0 \leq k \leq N-1$$

IFFT Logic*:* The inverse Fourier transform simply inverts the operation i.e. it converts from frequency domain back to time domain representation of the signal.

$$\mathrm{x(n)} = \frac{1}{N} \sum_{k=0}^{N-1} X[k]\, e^{\frac{i2\pi kn}{N}}; \quad 0 \leq n \leq N-1$$

Twiddle Factor*:* A twiddle factor helpful in calculating, Fast Fourier Transform (FFT) algorithms is some invariable coefficients product along with data as it would require within impersonated algorithm. It is helpful in recursively unite lesser discrete of Fourier transforms and is defined as

$$W_N = e^{\frac{-j2\pi}{N}}$$

Add cyclic prefix*:* The robustness of any OFDM transmission against multipath delay spread is achieved by having a long symbol period with the purpose of minimizing the inter-symbol interference. This ISI is a great drawback of digital communication system. To avoid this problem we have used cyclic prefix. Remove cyclic prefix is the same as Add cyclic prefix. It works same as Add cyclic prefix. Here is the eye diagram of the received signal after removing cyclic prefix.

1.3 Advantages of OFDM:

a) More spectral efficiency with respect to counterpart twice sideband modulation techniques like spread spectrum, etc.
b) Switch to harsh channel circumstances devoid of signal in time varying axis.
c) Resist alongside adjacent-channel having constricted bandwidth.
d) Vigorous next to inter-symbol interference (ISI) as well as fading occur due to multipath transmission.
e) By means of Fast Fourier Transform (FFT) calculate resourceful implementation.
f) Little compassion towards inaccuracy in instant time based synchronization.
g) Helpful in areas having distinct frequency network i.e., macro transmitter variety.

1.4 Disadvantages of OFDM:

a) Susceptible towards Doppler change
b) Responsive towards frequency synchronization trouble.
c) High peak-to-average power ratio (PAPR), require linear sender design, as it is already disadvantage of lower output power i.e. efficiency.
d) Using the guard band or cyclic prefix will lower effectiveness

1.5 Peak to Average Power Ratio (PAPR)

An OFDM having higher number of autonomously modulated sub-carriers the peak value of the method would be exceedingly high as compared to the average power of the method. The comparison of the peak power with respect to average power value is known as Peak-to-Average Power Ratio. This is very sensitive to non linearity of the high power amplifier maintained by same phase having peak value more than the average value using Coherent calculation. The main drawbacks of system having a towering Peak-to-Average Power Ratio are-

i) Comparatively higher intricacy in the analog system corresponding to digital and vice-versa in OFDM.

ii) Degrade the efficiency of RF amplifiers

iii) Degradation of BER performance

1.6 PAPR of a Multicarrier Signal[14]

Suppose that the data block of length N be represented by vector $X = [X_{O,} X_1 ..... X_{N-1}]^T$ .Duration of symbol having time T set ***X*** and represents one of the subcarriers *{n=0, 1, 2…N-1}* and the *N* sub – carriers selected to send out the signal are perpendicular. The OFDM signal is to be transmitted as:

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_K e^{\frac{-j2\pi nK}{N}} \qquad 0 \le t \le NT \qquad (1.4.1)$$

The Peak to Average Power Ratio of the broadcast signal is as

$$PAPR = \frac{\max |x(t)|^2}{1/T \int_0^T |x(t)|^2 \, dt} \qquad (1.4.2)$$

In equation of (1.2.2) $\max |x(t)|^2$ is crest value and $\frac{1}{T} \int_0^T |x(t)|^2 \, dt$ is average power signal.

1.7 CUMULATIVE DISTRIBUTION FUNCTION

CDF (Cumulative Distribution Function) is individual of the largely frequently used factor and used to measure the efficiency of any PAPR technique. The Complementary CDF (CCDF) is normally used instead of CDF and helps to measure the probability that the PAPR of a certain data block exceeds the given threshold.

By using the Central Limit Theorem for a multicarrier signal with a large number of sub-carriers and the real and imaginary division of the time – domain signals have a mean of zero and a variance with a Gaussian distribution as well as Rayleigh distribution is followed for the amplitude of the multicarrier signal.

The CCDF of the PAPR given as:

$$P(PAPR > z) = 1 - P(PAPR \leq z) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1.5.1)$$

$$= 1 - F(z)^N \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots ... (1.5.2)$$

1.8 ORGANISATION OF THESIS

Thesis organization of thesis as follows

In Chapter1, there is an Introduction to OFDM, principle of OFDM, its advantages and disadvantages, PAPR, PAPR of a multicarrier signal and CCDF Plot.
In Chapter2, there is various techniques of PAPR Techniques like amplitude and clipping, SLM, PTS and Precoding and also the review of literature.
In Chapter3, there is scope of study, objective and research methodology how we approach the new technique i.e. ZCT.
In Chapter4, there is Autocorrelation, CCDF plot, BER performance using by firsly SLM and then by ZCT.
In Chapter5, there is described that the proposed technique of ZCT is better than SLM and in future we may use DHT precoding or PTS for improvement.

Chapter 2

LITERATURE SURVEY

2.1 Introduction

In OFDM, the sub-carrier frequencies are selected with the intention that they perpendicular towards every carrier, means so as to remove cross- talk among the adjacent-channels along with inter-carrier guard bands must not be required. By doing this structure of transmitter along with receiver is very much simplified. OFDM need to use very precise frequency organization involving the receiver and the transmitter; by means of frequency digression the carriers having additional information will be parallel, leads to inter carrier interference (ICI) (i.e., cross- talk among sub- carriers).

2.2 Peak to Average Power Ratio Reduction Techniques

There are a number of techniques to remove the problem of PAPR.

1. Amplitude cutting
2. Clipping plus filtering
3. Precoding
4. Partial transmit sequence
5. Selected mapping
6. Interleaving

2.2.1 Amplitude clipping and filtering

Amplitude clipping is the basic technique by which PAPR is reduced in OFDM. A certain level is proposed and larger from it will simply cut-off and after that may be signal is filtered in respect to get lower reduction value. threshold value of the amplitude is set in this case to limit the peak envelope of the input signal and superior than this pre-determined value are clipped in addition to the respite are free to pass

Where,

$$V(x) = \{x, \quad |x| \le A \qquad \ldots\ldots\ldots\ldots (2.2.1)$$

$$V(x) = \{ Ae^{j\theta(x)} \quad |x| > A \qquad \ldots\ldots\ldots (2.2.2)$$

V(x) = the amplitude value after clipping.

x = the initial signal value.

A = the porch position used for cutting signal.

The different source of noise can be misleading lead to the identification occurred by the amplitude and clipping process. This distortion falls in both in – band and vice-versa. Filtering not performed to reduce the in – band distortion and an error performance degradation. Happenings the other hand spectral effectiveness is vulnerable by out – of – band emission. Radiations having bandwidth exceeding the band will lead to peak having higher in nature which can be undoing by the firstly clipping and after filtering. A repetitive algorithm can be put into practice to resolve this trouble and favored amplitude level is getting only by repeating above algorithm by many times.

2.2.2 Selected mapping [16-17]

The main purpose of this technique is to create data blocks which are in a set at the reception end; block having lower value is selected and further proceeded with respect to the original signal which is to be transmitted. Different fragments of blocks carried the pure data but are divided in parts in order to get the traffic lower. Choosing the information chunk through various blocks in order to get short reduction value put together it apposite for communication. By doing, in above technique relay on forming a chunk of original information but separated by various pre-defined information lump at the teller end so which represent the original signal and then chose most favorable block among them for transmission.

We are assuming an OFDM system with N orthogonal sub – carriers. A data block is a vector $X = (x_n)_n$ is composed of N complex symbols x_n.each symbol represent in form of modulation symbol transmitted over a sub – carrier. X is multiply by next ingredient by component with U vector $B_u = (b_{u,n})_n$ composed of N complex numbers $b_{u,n}$, $u \in \{0,1....U-1\}$ and. Each resulting vector $X_u = (x_{u,n})_n$ produces after IDFT, a corresponding OFDM signal given as

$$s_u = \frac{1}{N}\sum_{n=0}^{N-1} x_{u,n} e^{j2\pi knt/N}$$

Where *T* is duration under which OFDM having warning sign is already selected and 1/T is the sub – carrier spacing

along with modified figures sets carrying lowly PAPR is preferred intended for communication along with total PAPR value reduced intended for SLM relay upon the amount of sequences U having same or different phases.

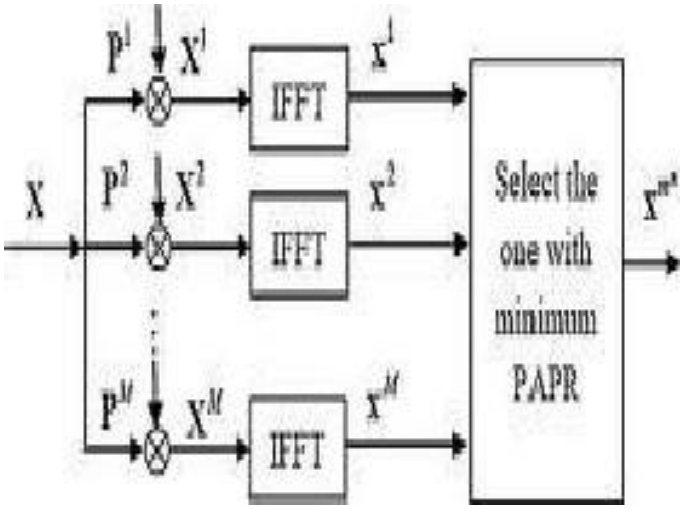

Figure 2.1 selected mapping

2.2.3 PARTIAL TRANSMIT SEQUENCE

Partial Transmit Sequence Technique we use the concept that sending only required part containing no more than ingredient of information of altering sub-carrier upon which all the receiving process relaying on covering all data sets and considered it as whole is defined as PTS. In PTS technique the enter data block X is divided within *M* put out of place sub-block $X_m = \left[X_{m,0,} X_{m,1.....} X_{m,N-1} \right]^T$, m=1,2…M and such that the sub blocks are collective to decrease the PAPR in the time domain. Assume the *L* times oversampled time domain signal

of X_m, m=1, 2….M is obtained by taking the IDFT of length *NL* on concatenated with *(L – 1) N* zeros and after that sequences are entitle as partial transmit sequences. Complex phase factors $b_m = e^{j\theta m}$, m=1 2…M are introduced to combine the PTSs. The set of phase factors is denoted a vector $b = [b_1, b_2, ...b_m]^T$ .The moment in signal having domain specified as time is subsequent to merge is given as:

$$x'(b) = \sum_{m=1}^{M} b_m . x_m$$

Where $x'(b) = [x_0'(b), x'_1(b).....x'_{NL-1(b)}]^T$. The objective is to find the set of phase factors that minimizes the PAPR.

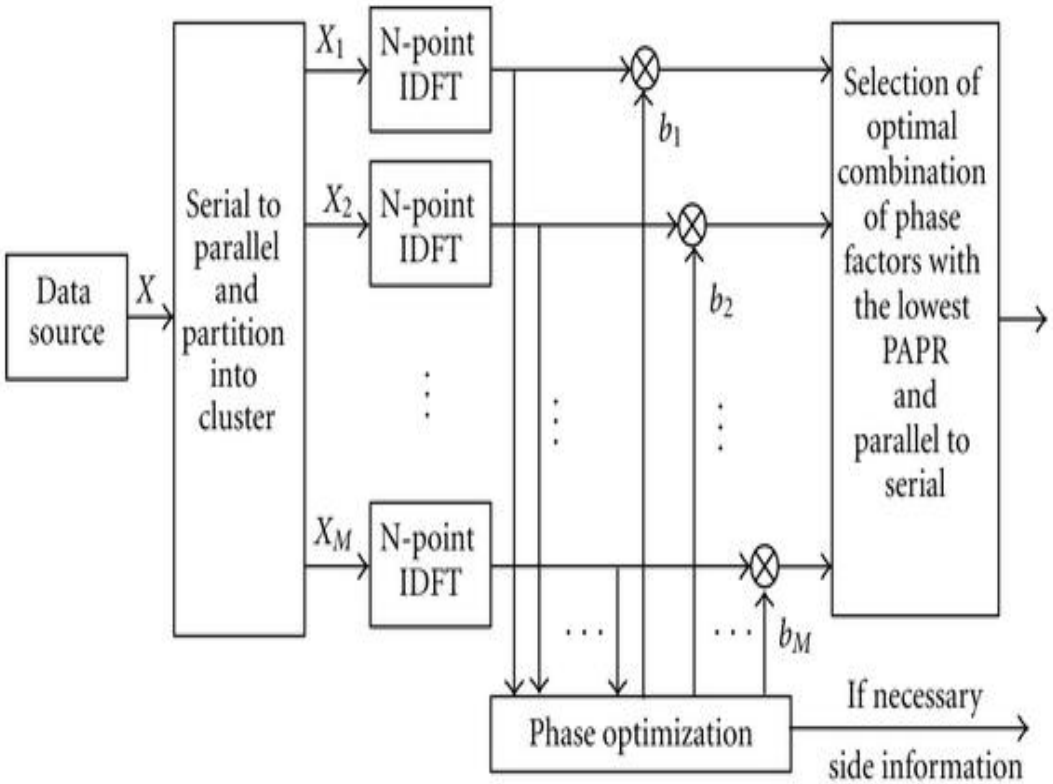

Figure 2.2 PTS scheme

2.3 Review of Literature

In this section explain many papers:-

SLM Technique with Precoding using VLM in support of PAPR Reduction in OFDM Systems [1]

A latest precoding technique have been planned based on Vandermonde-like matrix (VLM) moreover selective mapping (SLM) which are quite helpful in lowering PAPR within OFDM system. VLM precoding decrease the fact on autocorrelation of given pilot input sequences at the same time as SLM acquire a benefit of the reality with the purpose of the PAPR reduction is exceedingly susceptible toward signal having various phases. The key pro of this anticipated design to accomplish a noteworthy decline in PAPR not including effect of mounting the system complication.

PAPR of OFDM Signals with PTS Scheme by Low Computational Complexity [2]

Partial transmit sequences (PTS) is one of the most smart plan used toward decreasing the peak-to-average power ratio (PAPR) which is main disadvantage in orthogonal frequency division multiplexing (OFDM) systems. The usual PTS method entails a far-reaching searching over all possible arrangement of tolerable phase feature plus the calculating complication raise as soon as the quantity of the various sub-blocks increases exponentially by means of time. Make use of the correlation between the contender provided indications create in conventional Technique a new method is anticipated in order to diminish the system computational constantly difficulty. The design is capable of ease the calculating density considerably whereas both techniques attain the identical PAPR reduction put side by side as to the predictable PTS scheme.

PAPR Reduction of OFDM Signals using Pseudo Random PTS without Side Information [3]

We have many techniques in past in order to calculate the PAPR value..In OFDM area a new technique called as Partial Transmit Sequence i.e. PTS. The Conventional PTS (C-PTS) is go through from higher calculating intricacy and it entail side information in type of extra subcarriers in process of transmission and the extra information resolve the error mostly occurred called as spectrum efficiency in case OFDM systems and signal to noise ratio also increased up, hence many boast offer lead for eradicate that why we have to need of side information in this impersonated document except these already offered techniques

need various suggestion symbols through by means amplify the broadcast power either superior the involvedness inside receiver. In above defined on the subject of Pseudo-random using PTS which apply shifting of portioned blocks sequences is defined in order to exclude concept about additional proposed to remove the need of side information. . The anticipated method pull off almost the equivalent bit to error rate (BER) criteria while C-PTS in the company of ideal side in sequence below of frequency selection under fading circumstances.

PAPR Reduction Using Low Complexity PTS to Construct of OFDM Signals Without Side Information [4]

Partial transmit sequence (PTS) is the for the most renowned peak-to-average power ratio (PAPR) lessening procedure initiate in favor of orthogonal frequency-division multiplexing (OFDM) coordination. The key negative aspect of the conventional PTS (CPTS) is lofty computational processing time along with spread of various side in sequence bit. It is quite helpful to agreement among drawbacks of C-PTS by means of new PTS by straightforward detector. As a result be capable of be generated throughout cyclically shifting every subordinate block progression within time domain and coalesce them contained by a recursive style. On to sender side by make use of the natural assortment of phase gathering within unlike character with detector may effectively recuperate the unique sign exclusive of side information. Hence the likelihood of revealing malfunction of the extra information reveal with the purpose of the detector could work with no side information having soaring consistency. Consequently in above defined technique attain nearly the similar bit error rate (BER) values while the C-PTS among ideal side information via using proposed system in beneath in cooperation to additive white noise having Gaussian in nature noise (AWGN) channel with Rayleigh fading depending upon factors.

Pilot-Aided Side Information Detection in SLM-Based OFDM Systems [5]

Selected mapping (SLM) based technique is more effectively by which we can reduce the peak-to-average power ratio (PAPR) in orthogonal systems having differed in frequency using multiplexing i.e. OFDM systems. Conversely at what time we have need of side information (SI) communication along with side means additional information a thrashing in the facts throughput is occurred along with in the augmented structure complication. So we know there is a blind scheme having SLM foundation on a decision of various channel response having similar to each other using concept of a metrics. So a work of fiction SI

discovery process is proposed having lesser computational complexity as defined in case of an OFDM Systems. In order to take advantage of the elevated autocorrelation among adjoining channel having similar in nature rejoinder thus SI detected.

Effect of PAPR Reduction on Spectrum and Energy Efficiencies in OFDM Systems with Class-A HPA over AWGN Channel [6]

It proposed a new technique we are scrutinize the relationships amid Spectrum as well as Energy efficiency (EE) which put a great effect on peak-to-average power ratio (PAPR) decline in case of orthogonal frequency division multiplexing (OFDM) scheme. The effectiveness of high power amplifier (HPA) possibly will be significantly enhanced in the course of PAPR decline and another factor i.e. the nonlinear deformation of noise origin on the basis of the HPA would be drastically reduced. Consequently because a outcome the SE and EE be greater than before through a full amount convey power in excess of additive white Gaussian noise (AWGN) channel.

A Weighted OFDM Signal Scheme for Peak-to-Average Power Ratio Reduction of OFDM Signals [7]

inside this technique a design foundation taking place a biased orthogonal frequency-division multiplexing (OFDM) sign is helpful in reducing the PAPR exclusive of misrepresentation in eradicate the load on the recipient side furthermore a mass is compulsory on every discrete OFDM sign by the use of a confident sort of band inadequate indication, also accordingly an OFDM signal created by way of the weighted distinct statistics is subsequently well thought-out prior to a high power amplifier (HPA), while the unique indication be capable of be well again wholly received at the receiver side plus point in instant period desired to put out the weighted OFDM signal is the equivalent at the same time as the moment extent intended used for the original OFDM signal less significant than that of the amplitude clipping and filtered out (C&F) scheme with the bit-error-rate (BER) routine of the prejudiced OFDM classification is enhanced put side by side amid the C&F means. Hence, the anticipated method is easier instead of using the C&F method.

Reducing the Peak-to-Average Power Ratio of OFDM Signals during Precoding [8]

Orthogonal-frequency-division-multiplexing (OFDM) techniques let the broadcast of sky-scraping statistics rates greater than the communication radio channels headed for multipath loss devoid of necessitate used for dominant channel equalized. Signals are

extremely susceptible toward nonlinear belongings because of the greater peak-to-average power ratio (PAPR) through their put out gesture. In this manuscript put forward an well-organized modus operandi designed for dipping the PAPR in OFDM systems. The decrease in PAPR in case of the OFDM systems is get hold of all the way through a suitable choice of a precoding method so as to transmit the authority of every one alter character greater than the OFDM building block. The good improvement in PAPR can also be achieved through by the predefined procedure authorize the lessening of the involvedness along with expenditure of the spreader drastically so the precoding plan what's more acquire gain of the frequency dissimilarity of the communiqué feed so that be capable of offer substantial routine increase in faded in multipath channel.

On Partial Transmit Sequences for PAR Reduction in OFDM Systems [10]

Partial transmit sequences (PTS) is a well-liked procedure helps us to diminish the peak-to-average power ratio (PAPR) within orthogonal incidence dissection multiplexing (OFDM) system. PTS be exceedingly victorious during PAPR lessening furthermore competent redundancy exploitation, other than the extensive calculating complication intended for the requisite explore all the way during a higher defined dimensional vector is quite helpful to agreement among drawbacks of C-PTS by means of new PTS by straightforward detector. As a result be capable of be generated throughout cyclically shifting every subordinate block progression within time domain and coalesce them contained by a recursive style. On to sender side by make use of the natural assortment of phase gathering within unlike character with detector may effectively recuperate the unique sign exclusive of side information. Hence the likelihood of revealing malfunction of the extra information reveal with the purpose of the detector could work with no side information having soaring consistency. Consequently in above defined technique attain nearly the similar bit error rate (BER) values while the PTS.

Orthogonal frequency division multiplexing: It isa multi-carrier modulation scheme[11]

An analysis of the procedure as well as its progress and execution are provided. The compensation and shortcoming within comparison to additional intonation technique be also talk about The thoughts of by means of a guard time in the direction of lodge long holdup and creating band notches to conflict co-channel interferences, seeing that of conveying different order of modulation or influence levels to unlike sub-carriers designed for layered

armed forces are talk about The personal property of chapter noise with the peak-to-average control proportion of the OFDM signal are too analyzed.

COFDM: An overview [12]

In order to explore and progress in case of OFDM as well as COFDM meant for digital television dissemination has established significant attention and has completed a vast deal of evolution in Europe. OFDM/COFDM has by now been implementing in digital audio diffusion and is also living being considered in favor of worldly digital television and High Definition TV broadcasting. The compensation of COFDM claimed by the promoter in Europe have in addition caught the attention of US anchor and create eagerness although a digital carrier system called 8-VSB for two has been select set by the FCC commission to Advisory Committee for the on Advanced Television Service (ACATS) for the final testing. There is considerable dispute in foyer the in demine faddy spry over for hothead use of COFDM vide ns dukes VSB or QAM for global HDTV dissemination. In this paper, the time gone by of research and enlargement on OFDM and COFDM is assessment then; the fundamental principles, act and execution of OFDM and COFDM are examined. Psychoanalysis is agreed to facilitate the selection of key basics for conference the constraints of the requisite relevance pedestal resting on the ATV conduit model, routine expectation of COFDM less than deficient strait conditions and accomplishment concern are scrutinize in details.

PAPR reduction in OFDM transmission using Hadamard Transform [13]

As we know OFDM system are more exposed to PAPR effects, accordingly the degradation in power (in band distortion) along with spectral beam scattering (out-of-band radiation) achieved through a power amplifier. It is a very good technique for lowering PAPR. Also from investigation, it has been defined that autocorrelation function as well as CCDF plot for PAPR are controlled simultaneously.

Chapter 3

RESEARCH METHODOLOGY

3.1 Scope of the Study

In this research, the main goal is the reduction of PAPR of OFDM system because PAPR is the serious problem of OFDM system. So due to the PAPR will degrade the BER performance of the OFDM system and hence it leads to the poor OFDM spectrum efficiency and system capacity.

In this dissertation we are reducing the PAPR with help of the PAPR reduction technique such as SLM with ZCT Pre-coding Matrix with the different modulation technique (QAM, QPSK, and BPSK) and achieve significant PAPR reduction.

Here, we are using ZCT (Zadoff-Chu matrix Transform) so one a critical challenge is that the phase factor information is required to be transmitted to the receiver as side information. Due to the side information, reduce the transmission efficiency and augmented computational complexity because several error in the detection of side information then the entire data blocked and could be damaged .So in this paper, we used error correcting codes prevent for damaging and blocking the data and also in ZCT there is no side information concept used.

3.2 Objective

ZCT Precoded used alongside SLM Technique in order to calculate PAPR Reduction in OFDM Systems

Procedure

1. Analyze the OFDM system with SLM technique.
2. Then analyze various modulation techniques like QAM, QPSK or BPSK.
3. Then after that analyze PAPR reduction technique like SLM
4. After take ZCT Transform and further helpful in calculating the PAPR & BER.
5. Develop the problem based upon analysis.
6. Obtain the output based result of the program.
7. Analyze different result for different input parameters.

3.3 Research Methodology

Zadoff-Chu codes are the particular case having the generalized Chip-Like polyphase sequence having large amount favorable correlation possessions. The Zadoff-Chu is sequences which are complex in natural world, as soon as these sequences are helpful in applied and when they applied to the radio signal and furnish an electromagnetic gesture with stable amplitude. These sequences are class of poly phase sequences having optimum correlation properties and having an ideal periodic autocorrelation and constant magnitude. When they cyclically the shifted version of the sequence is imposed on a signal result in zero cross-correlation. Zadoff-Chu matrix transform pre-coding has been introduced in which can be reduces the PAPR parameter of any OFDM systems. This technique uses Zadoff-Chu sequences of length '*L*' which can be define as equation

$$z(k) = \begin{cases} e^{j\frac{2\pi r}{L}\left(\frac{k^2}{2}+qk\right)} & \text{for } L \text{ even} \\ e^{j\frac{2\pi r}{L}\left(\frac{k(k+1)}{2}+qk\right)} & \text{for } L \text{ odd} \end{cases}$$

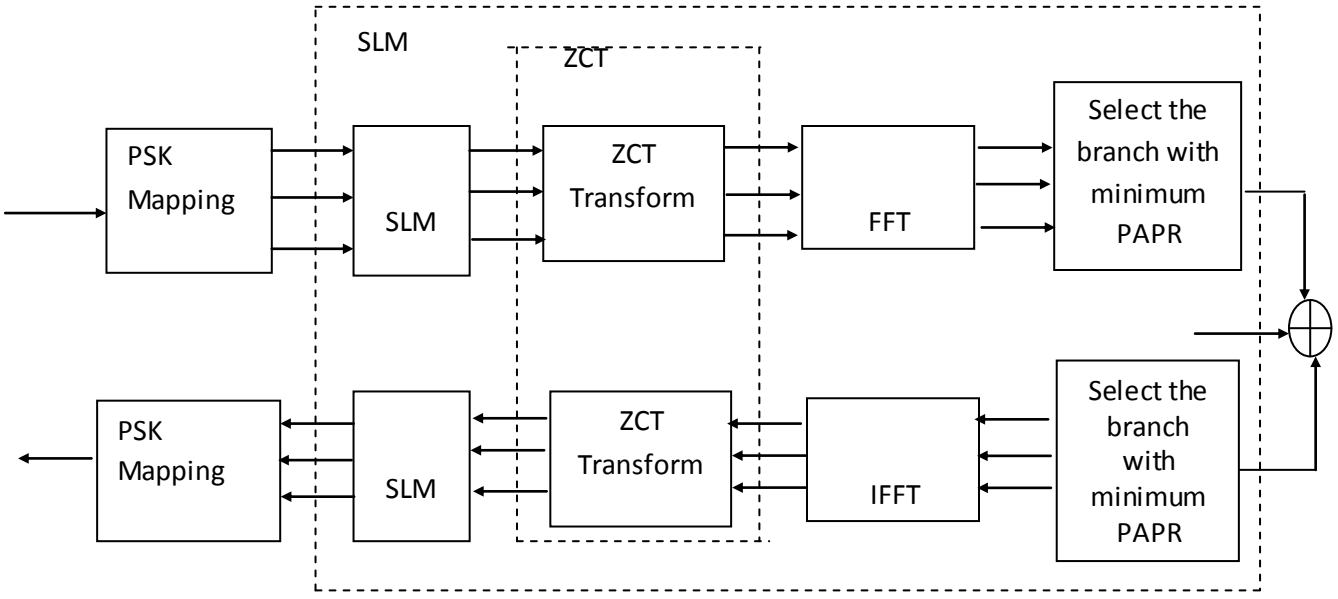

Figure 3.1 Block diagram of ZCT precoded SLM OFDM system

Chapter 4

RESULT AND DISCUSSION

4.1 Introduction

In this section, various results of the methodology have been placed which are implemented in Matlab software.

4.2 The key idea of this article is to use VLM transformation to reduce the autocorrelation of the input sequence and also the various techniques like BPSK, QPSK & QAM which will reduce PAPR of the OFDM systems.

Results: - it is concluded so as VLM transform be able to re-correlate the input sequence also consequently the PAPR is also reduced.

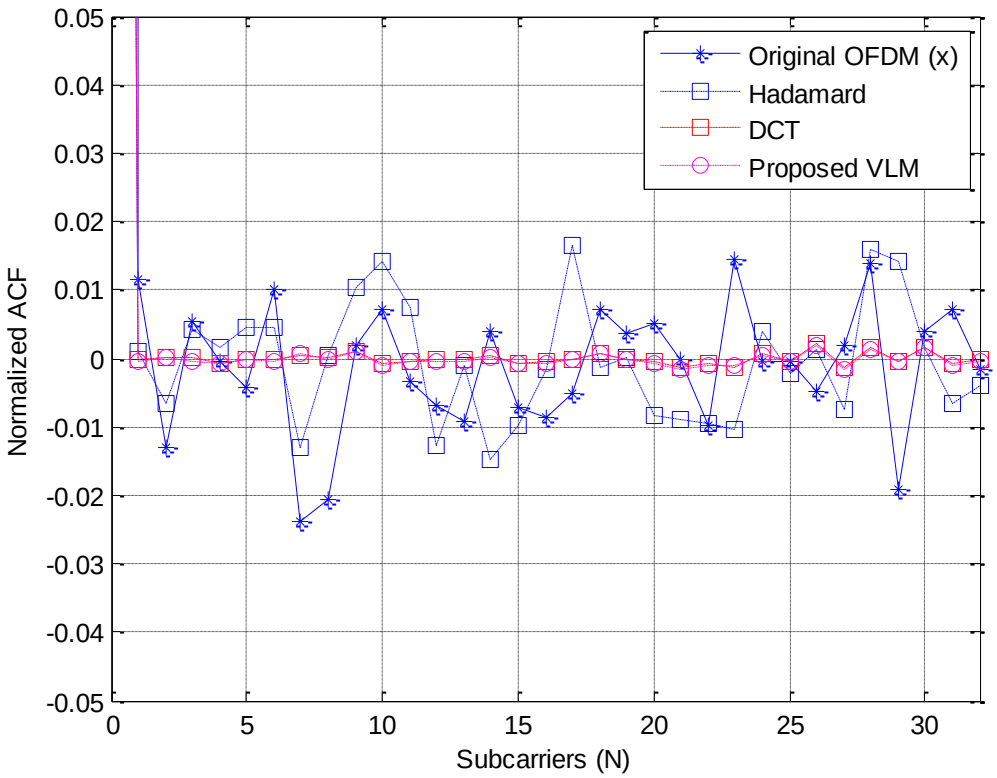

Figure 4.1 The normalized autocorrelation function having original signal and signals precoded with existing techniques and proposed technique, for N=32.

Figure shows the contrast of autocorrelation purpose of original sequence, Hadamard, DCT and proposed VLM precoded sequences. It is obvious that, if the side-lobes of autocorrelation

n shows higher values, then the input sequence is highly correlated and thus the PAPR. When highly associated sequence is given to the IFFT input, the subcarriers will be aligned in-phase.

4.3 The PAPR reduction performance calculates by means of the complementary cumulative distribution function (CCDF) of the PAPR using BPSK using SLM.

Result:- Fig 4.2 shows that the VLM precoding can achieve 0.7 dB PAPR gain over DCT precoding, 2 dB above Hadamard precoding and about 6 dB over normal OFDM systems at CCDF = 10−3.

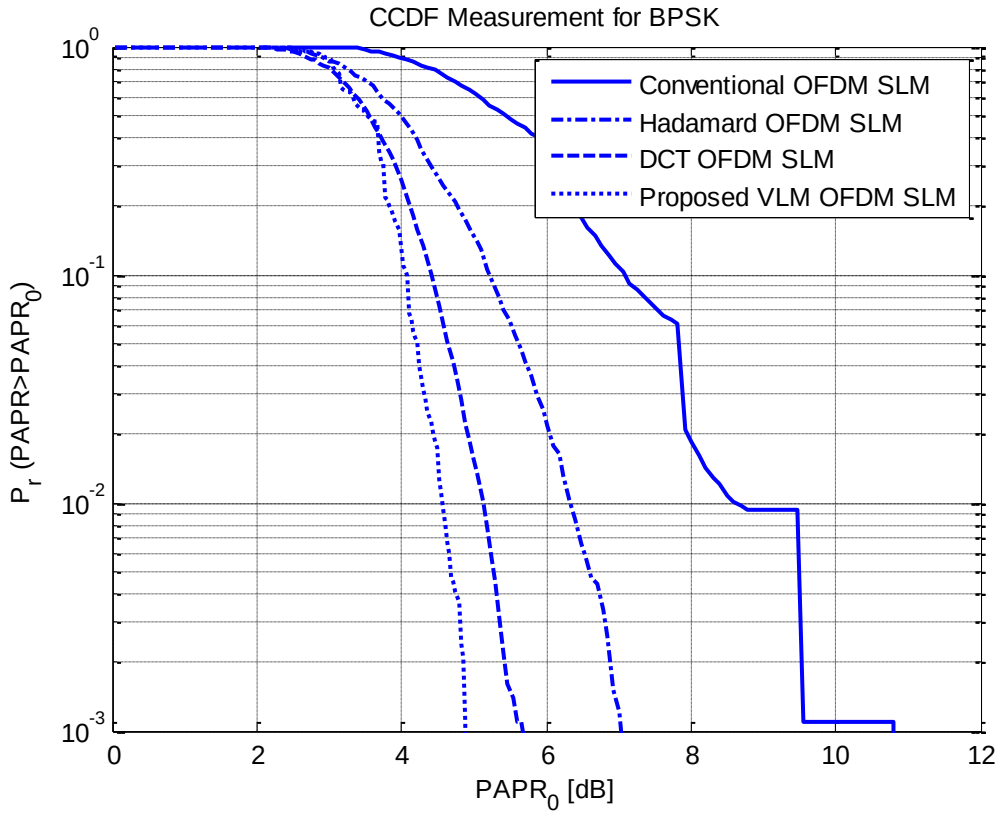

Fig. 4.2 CCDF of PAPR with conventional precoding techniques and the proposed method for BPSK SLM OFDM,

The PAPR reduction performance be evaluated using the complementary cumulative Distribution function (CCDF) of the PAPR, which specify the probability that the PAPR of an OFDM sequence could surpass the threshold level PAPR0. Figure 4.2 illustrate the CCDF of an OFDM system have no PAPR reduction scheme (denoted as 'original OFDM'), the conventional precoding methods, and the proposed method.

4.4 In this type we measure the PAPR of various signals like Original OFDM,Hadamard ,DCT and Proposed VLM using QPSK Modulation Technique.

Result:- recreation explain that the proposed method can achieve 0.2 dB PAPR gain over DCT–SLM, 1.3dB gain over Hadamard SLM and 2.3 dB gain over conventional SLM at CCDF = 10−3. Figure 4.3.

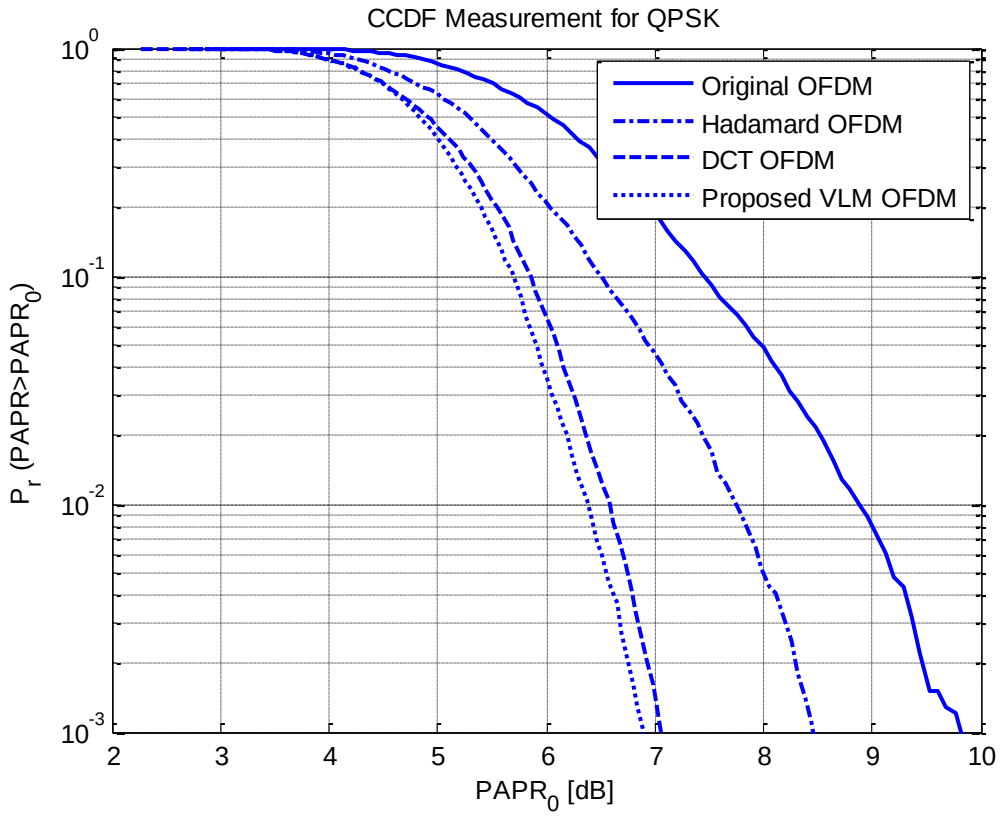

Fig 4.3CCDF of PAPR with original signal and proposed VLM for QPSK OFDM

Simulation shows with the aim of the proposed method can achieve 0.2 dB PAPR gain over DCT–SLM 1.3dB gain over 1.3dB gain over WHT-SLM and 2.3db gain over conventional SLM.

In order, by employing extra redundant bits, PAPR able to be further reduced. Also by this technique PAPR is reduced alongside Bit-Error-Rate (BER) performance is also lowered.

4.5 In this type we measure the PAPR of various signals like Original SLM, Hadamard SLM,DCT SLM and Proposed VLM using QPSK Modulation Technique with SLM.

Result:- For contrast, the SLM scheme (denoted 'conventional SLM') and the SLM scheme with VLM precoding (denoted 'proposed method') were measured collectively. As we further use the SLM instead of original signal, then the result is further improved as seen here. So we can further improve the result by using the selected mapping data.

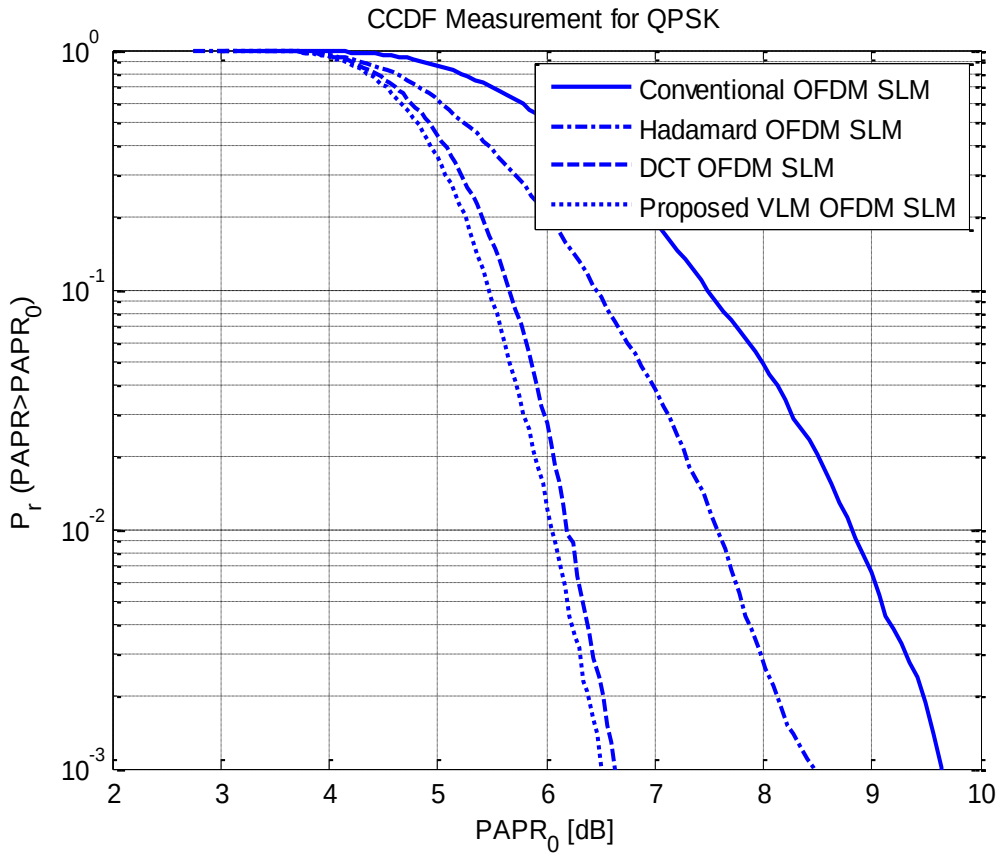

Fig 4.4 CCDF of PAPR with conventional SLM, Hadamard, DCT and proposed VLM precoded SLM for QPSK OFDM

4.6 To comparison the various signals i.e. Original, Hadamard, DCT And proposed VLM using QAM Modulation using SLM Technique.

Result:- As we further use the SLM instead of original signal, then the result is further improved as seen here. So we can further improve the result by using the selected mapping data.

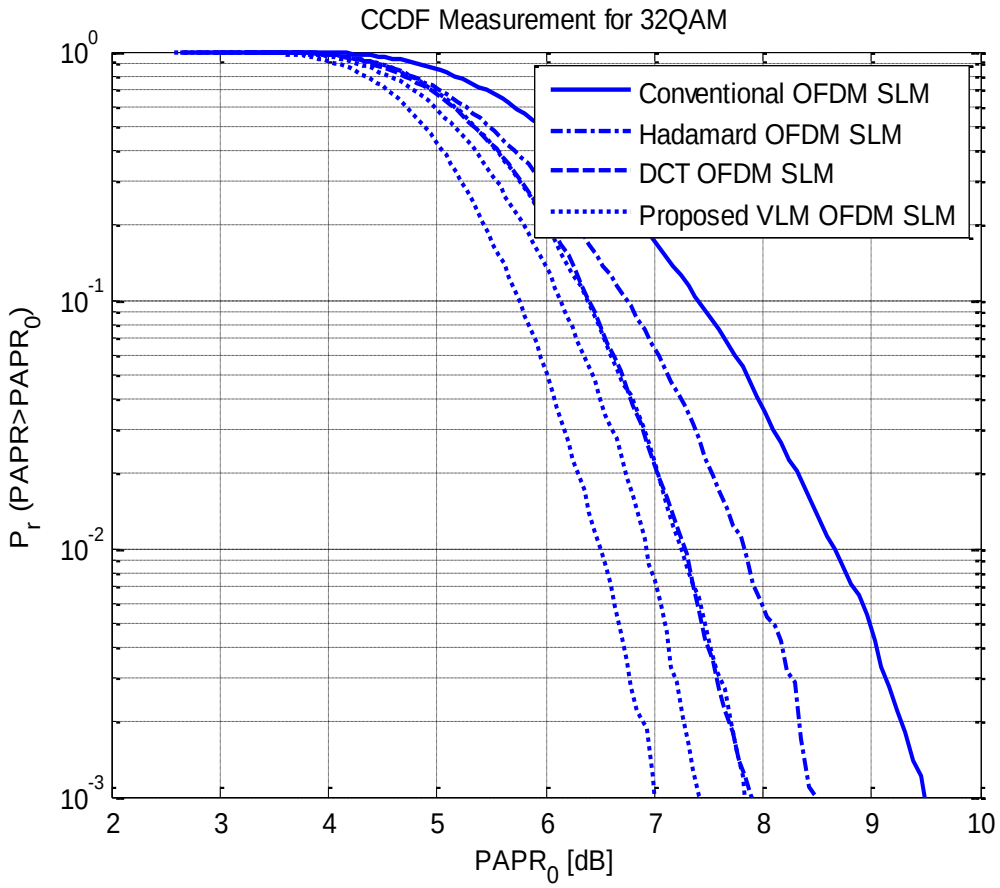

Fig 4.5CCDF of PAPR with original signal and proposed VLM for QAM with SLM OFDM

4.7 To comparison the Bit Error Rate of the various signals i.e. Original, Hadamard, DCT And proposed VLM.

Result: - The output we fetch is that the BER curve is nearly to the another rates as we use the phase sequence

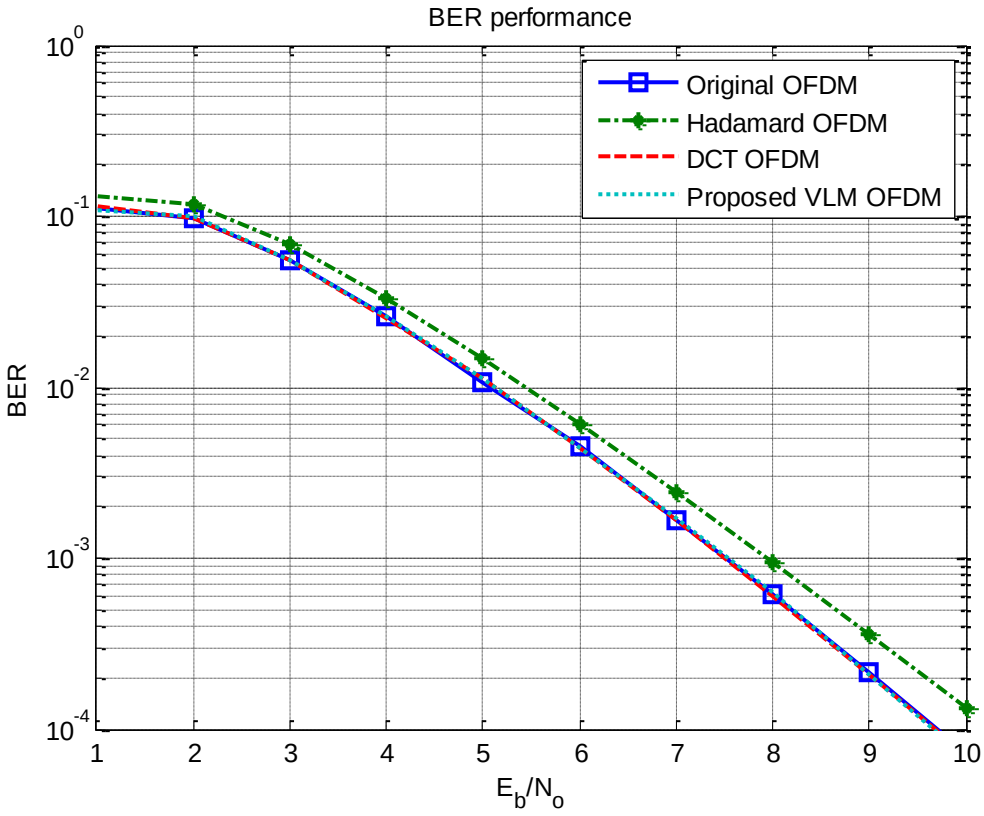

Fig 4.6 BER performance of OFDM systems with conventional precoding schemes and the proposed method

4.8 The key idea of this article is to reduce the autocorrelation of the input sequence and using ZCT Transform.

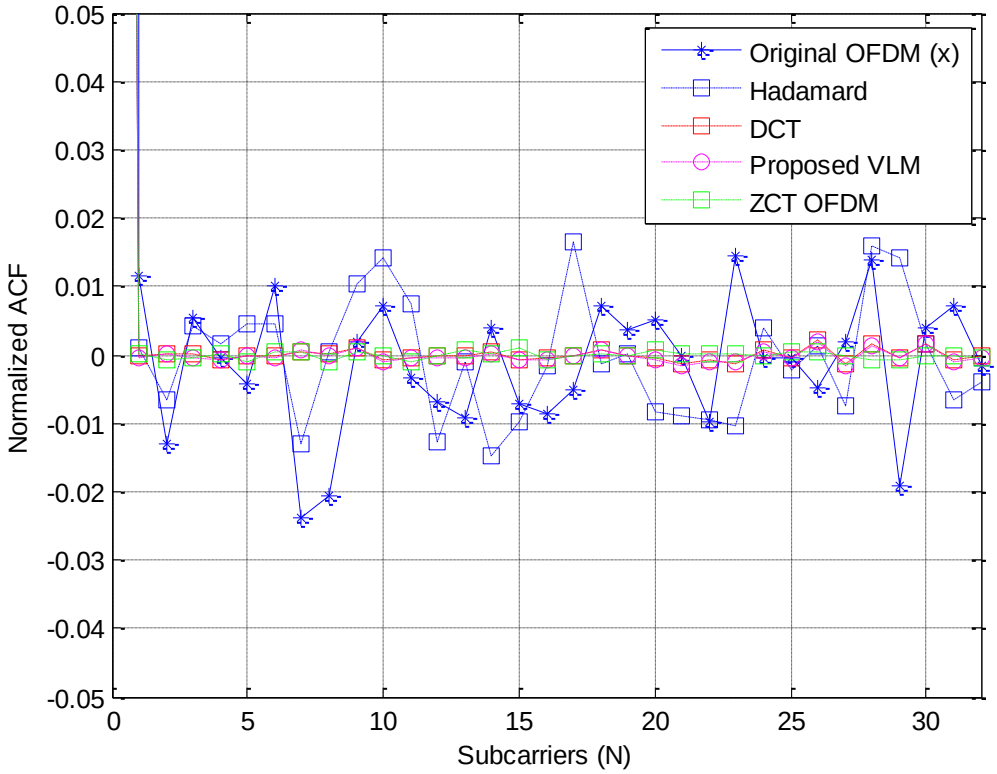

Fig 4.7 The original signal having normalized autocorrelation function , precoded with existing techniques and proposed ZCT technique, for N=32.

Result:-The autocorrelation function is very less fluctuating corresponding to another signal. It based on the fact that the function having the lower PAPR value will also have the lower auto-correlation value so helping in describing the fact that the there is also very useful for us to define that there is also very much important to produce the autocorrelation graph, so from the diagram that the it is clear that the ZCT has the significant advantage over the other precoding techniques.

4.9The PAPR reduction performance estimate with the complementary cumulative distribution function (CCDF) of the PAPR using QPSK with SLM and ZCT.

Result:-In case of QPSK Modulation Technique, there is a gain of 1 db of the VLM Precoded OFDM System.

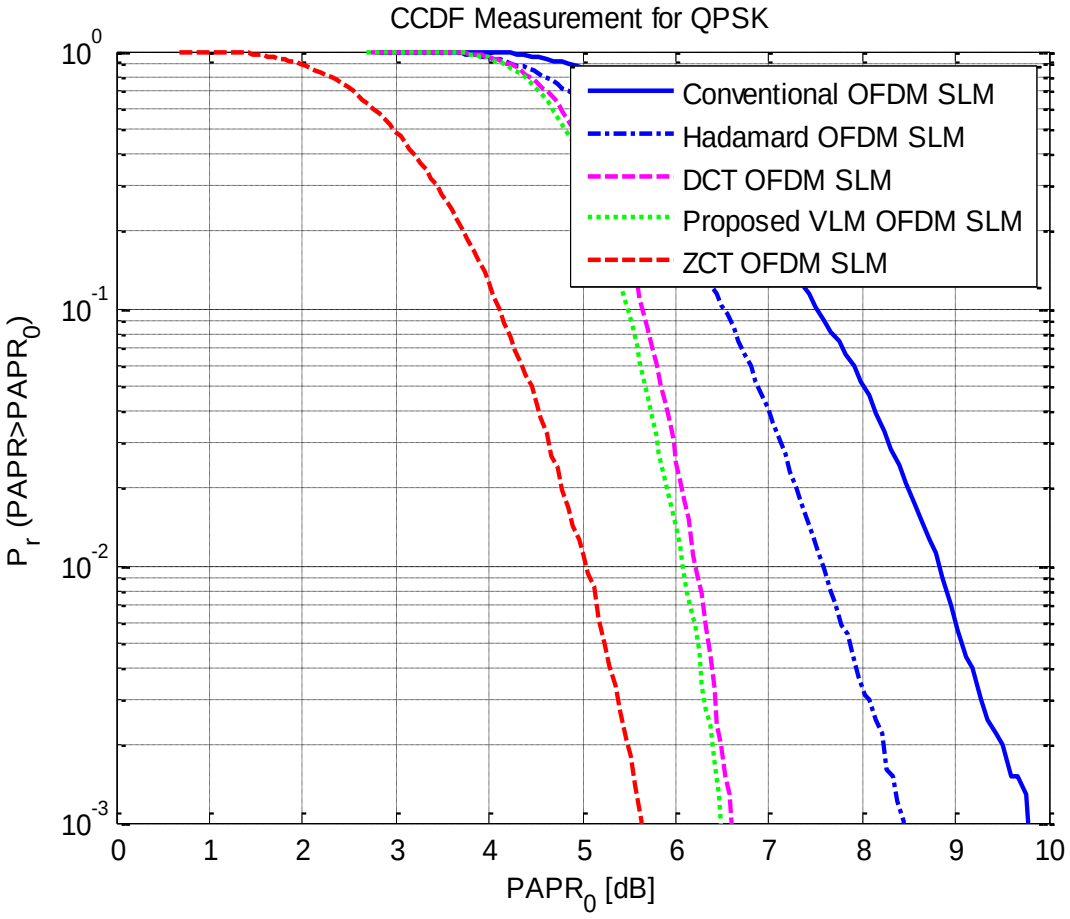

Fig 4.8CCDF of PAPR with original signal and ZCT with SLM for QPSK OFDM

The gain of the Conventional OFDM SLM is 2.4db to that of the Hadamard OFDM SLM and 4.6db to that of the DCT OFDM SLM and also minutely better than that of the Proposed VLM OFDM SLM 4.7db as than that of original OFDM using SLM and having ZCT OFDM SLM which is further improvement in showing the 4.8 db as that of the other precoding techniques used here.

4.10 The PAPR reduction performance is calculate via the complementary cumulative distribution function (CCDF) of the PAPR using BPSK with SLM and ZCT.

Result:-In the CCDF, the BPSK modulation there is a gain of 0.5db over the proposed vlm technique.

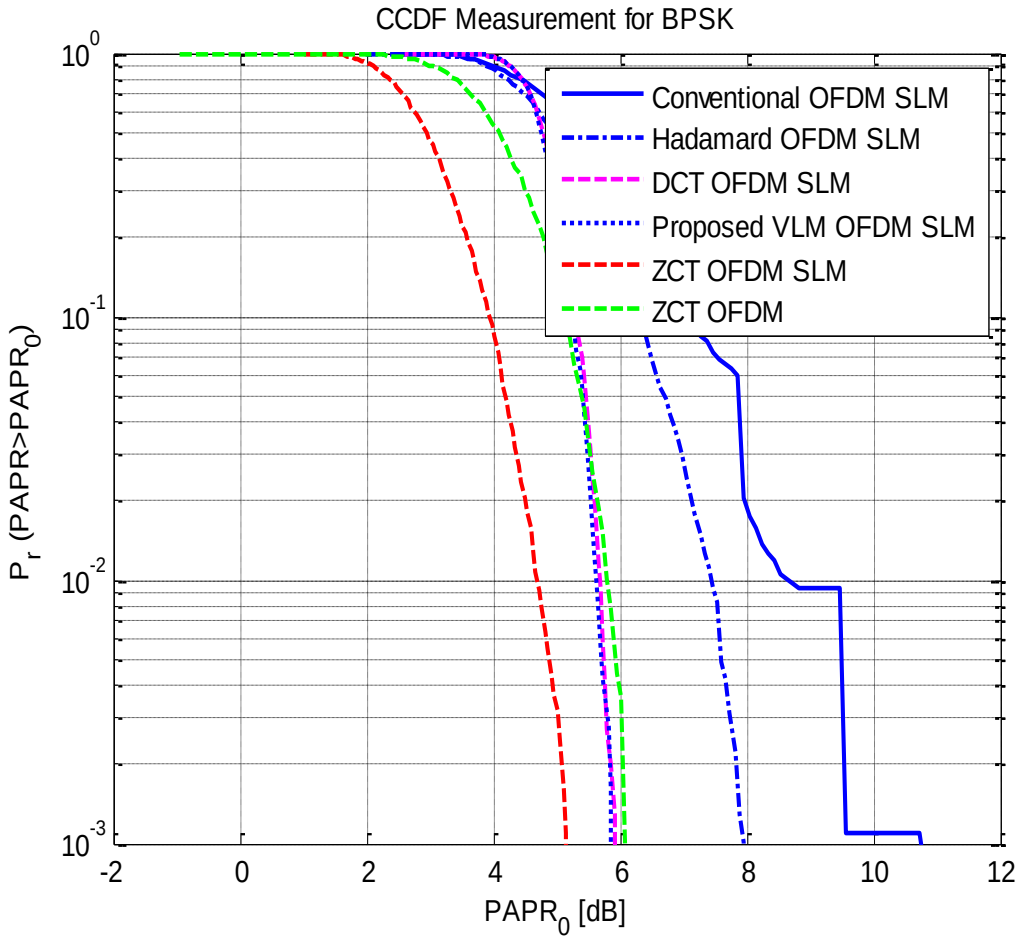

Fig 4.9CCDF of PAPR with original signal and ZCT with SLM for BPSK OFDM

The gain of the Conventional OFDM SLM is 2.3db to that of the Hadamard OFDM SLM and 4.2db to that of the DCT OFDM SLM and also minutely better than that of the Proposed VLM OFDM SLM 4.4db as than that of original OFDM using SLM and having ZCT OFDM SLM which is further improvement in showing the 5.1 db as that of the other precoding techniques used here.

4.11The PAPR reduction performance is calculate with the complementary cumulative distribution function (CCDF) of the PAPR using QAM with SLM and ZCT.

Result:-In case of QAM Technique there is a gain of 0.5db than to that of the previous occurred VLM precoding with SLM Technique.

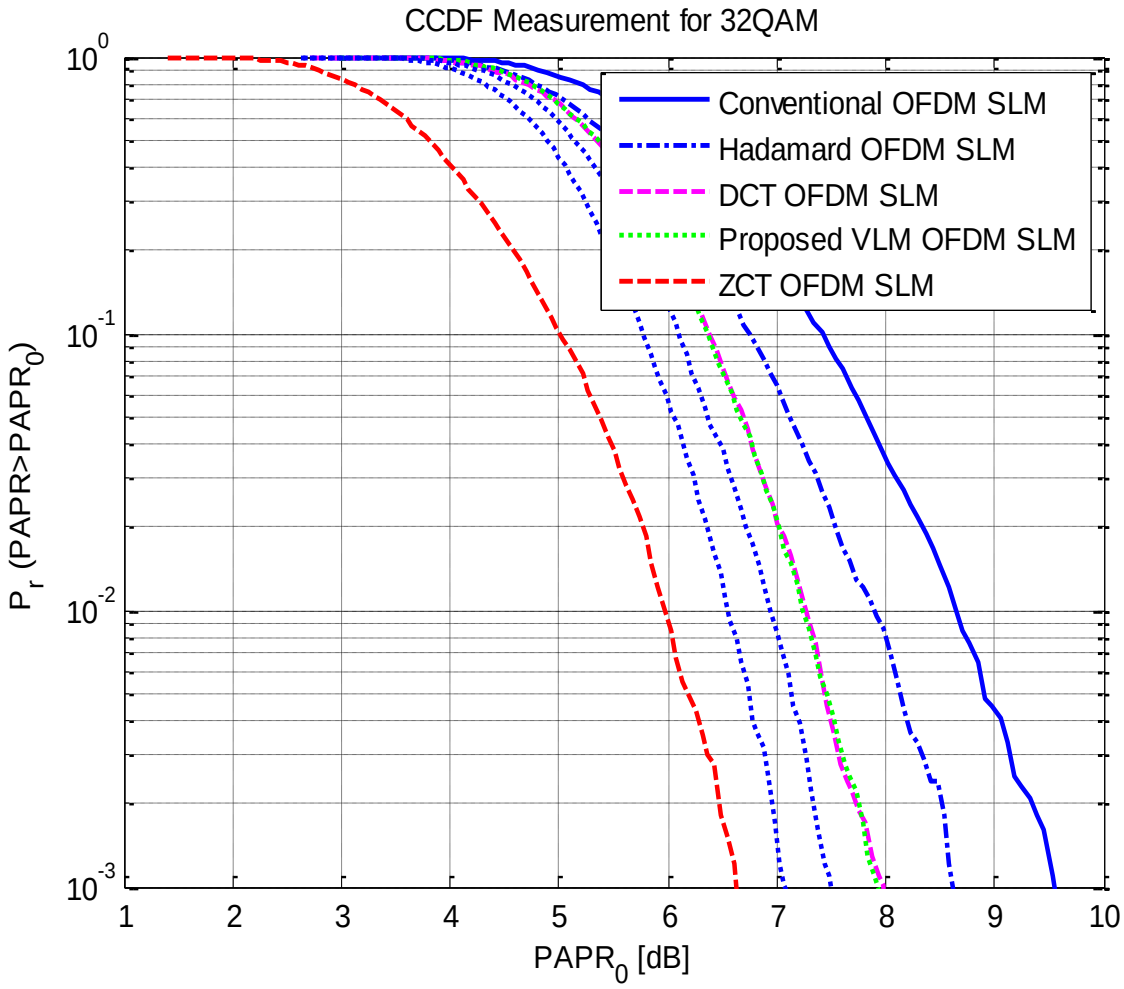

Fig 4.10CCDF of PAPR with original signal and ZCT with SLM for QAM OFDM

The gain of the Conventional OFDM SLM is 1db to that of the Hadamard OFDM SLM and 2.5db to that of the DCT OFDM SLM and also minutely better than that of the Proposed VLM OFDM SLM 2.7db as than that of original OFDM using SLM and having ZCT OFDM SLM which is further improvement in showing the 3.1 db as that of the other precoding techniques used here, we also use the concept of the various phase factors in QAM.

4.12 To comparison the Bit Error Rate of the various signals i.e. Original, Hadamard, DCT And proposed VLM.

Result:-The final output of the BER Performance is same as that of another OFDM precoding techniques or we can say that BER for ZCT is little bit lower in case of the others precoding techniques used.

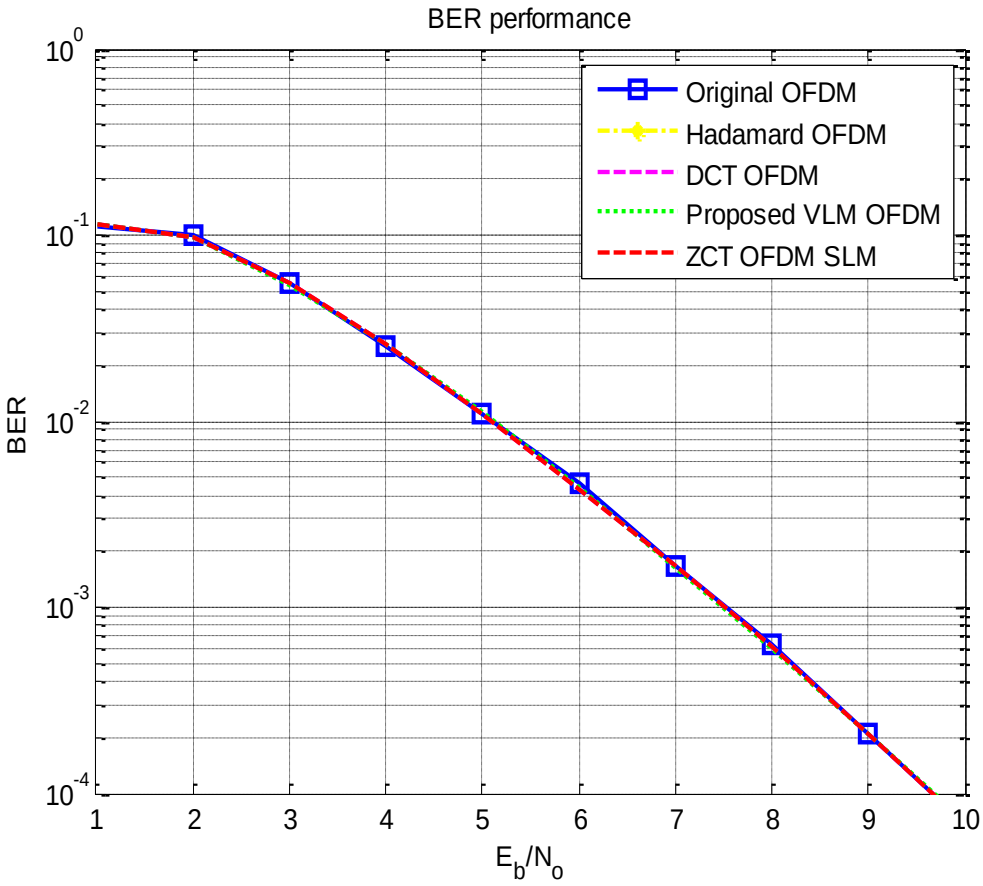

Fig 4.11BER performance of OFDM systems along with conventional precoding schemes the proposed method i.e. ZCT Transform.

CONCLUSION AND FUTURE WORK

CONCLUSION:-

Orthogonal frequency division multiplexing (OFDM) is a incredibly attractive technique for communications due to its spectrum effectiveness plus channel toughness. It has only single serious drawbacks in OFDM systems are that the composite transmit signal can put on view an extremely elevated peak power while the input series be exceedingly correlated. In the above mentioned technique, it has been proposed a ZCT precoding combining with SLM technique to decrease the high PAPR produce by multi carrier modulation in the OFDM defined systems. The PAPR reduction performances are evaluated by MATLAB simulation in terms of CCDF and BER. It was shown that proposed precoding method performs better than the conventional precoding techniques without mounting the complexity of the system or degrading the BER. Simulation results and mathematical analysis are given to support the statement.

FUTURE WORK:-

In future we may improve the PAPR Reduction graphs by using the DHT Technique (Discrete Hartley Transform)[19] or by using the DHT Precoding Technique with the ZCT Transform means Hybrid Technique, so as to achieve the better PAPR results.

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