A CRITIQUE STUDY ON PHASE OPTIMIZED GENERALIZED DISCRETE FOURIER TRANSFORM BASED PARTIAL TRANSMIT SEQUENCE FOR PAPR IN OFDM SYSTEMS

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ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) is a revolutionary digital modulation technique which known as a next generation of wireless communication 5th Generation. OFDM supports high speed data rate and multi user technique where it can accommodate large number of users showing spectral efficiency to meet the fast growing demands for better throughput and quality of service. However, OFDM-time domain signal suffering from a large peak-to-average power ratio PAPR .Fortunately several schemes have been proposed to reduce the problems of PAPR. One of the effective methods is partial transmit sequence PTS with pseudo-random sub-blocks portioning as it has better PAPR performance. Many techniques introduced to improve the performance of PTS scheme. In this paper a critique study on the use of phase optimized from the theory of generalized discrete Fourier transform GDFT is carried out. this method, generates nonlinear phase to OFDM sub blocks after taken of IFFT for each sub block, then the output phase is rotated by coefficients depending on number of side information bits 'm' to produces minimum PAPR. Simulation results elaborate that phase modification of OFDM frames before applying PTS that has achieved acceptable reduction in both complexity and PAPR.

Keywords: generalized discrete Fourier transform PAPR, OFDM, PTS, OFDM.

INTRODUCTION

Recently years and seems the huge increase in mobile devices .millions of mobile devices are on the market and the number is still counting. The mobile devices would be continually increasing rapidly as new cutting edge technology is driven by the large users also we have OFDM-based downlink transition scheme for multi user wireless communication system. It can accommodate more number of users showing spectral efficiency [2]. OFDM is a key of broadband wireless technology which supports data rates in excess of 100Mbps. OFDM employs multiple carrier that are orthogonal to one another over a given time interval Thus an appropriately designed OFDM system converts a frequency selective fading channel into a set of parallel narrowband flat fading channel across the subcarrier, which reduces the complication of the equalizer design [6]. OFDM forms the basis for 4^{th}Gcellular standard LTE wireless communication system WiMAX "Worldwide Interoperability for Microwave Access". It can support high speed video communication along with audio with elimination of ICI" Inter Carrier Interference "at the same time ISI" Inter Sample Interference". [2] Amongst all attractive pros of OFDM, there are some cons of OFDM e.g. such as sensitivity to Doppler shift, subcarrier frequency offset, High Peak to Average Power Ratio (PAPR) requiring linear transmitter, which suffers from poor power efficiency also loss of efficiency caused by cyclic prefix. However the main drawback in OFDM system is PAPR and BER (Bit Error Rate). [4] During

OFDM system stages the sensitivity of devices used in OFDM transmitter such as DAC (Digital to Analogue Convertor) and HPA (High Power Amplifier) is very disturbing to the signal processing loop which negatively affect in system performance. To achieve high output power efficiency, most radio based system operates HPA at or near its Saturation region. The high PAPR may prevent HPA to operate in its linear region and may cause OOB (Out of Band radiation), and IB (In Band) distortion. Rest of the paper is organized as follows: in first section present briefly the Basic concept of OFDM, subcarrier orthogonality, RF non-linearity in OFDM transverse, then PAPR in OFDM. The Second section gives the related work. The third section, discuss the PAPR reduction methods and their classification then explained briefly the Partial transmit sequence scheme and some techniques that have been proposed with PTS performance, then the main features of PAPR reeducation. In the following sections explain the generalized discrete Fourier transform then investigate the GDFT with PTS reduction methods along with their performance comparisons for various conditions. The last sections explain the simulation results and conclusion.

BASIC CONCEPT OF OFDM

The basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers. Before transmission, a cyclic prefix is added to OFDM symbols in order to avoid Inter-symbol

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Interference (ISI) in Frequency selective fading channels. OFDM effectively converts a wideband frequency selective into a collection of a parallel narrowband flat fading channels, thus removes the effect of inter symbol interference, and it uses the IFFT, FFT based designs it is also a very low in implementation complexity. The complex baseband representation of OFDM signal with N subcarrier is given by [11]:

$$S(t) = \sum_{i=0}^{N-1} X_i \; e^{j2\pi i \frac{B}{N} i} \tag{1}$$

Where B is the total bandwidth of the system and N is number of subcarrier, B/N is the center frequency of the subcarrier.
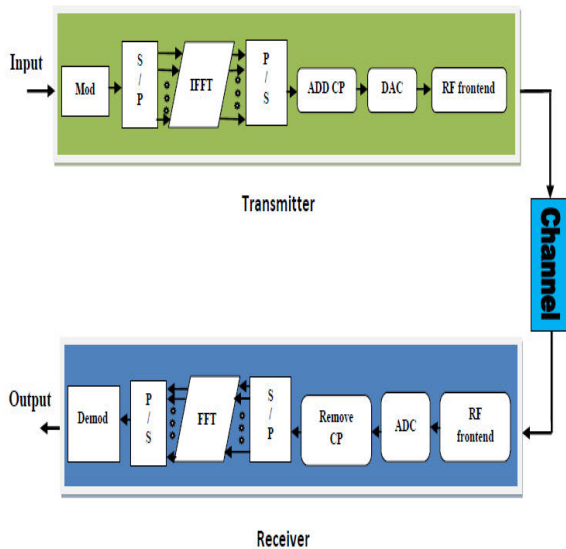

Figure-1. OFDM transmitter and receiver.

SUBCARRIERS ORTHOGONALITY

Orthogonality of carrier is very important because it insures the signal can be separated at receiver even though they overlapped together which element ICI" Intern ICI" Intern Carrier Interference "at the same time ISI" Inter Sample Interference "by using cyclic prefix which remove the impact of ISI. [9] As the carrier orthogonality we have to transmit data in parallel hence we have high data rates .more over subcarriers orthogonality will saving the bandwidth of the system.
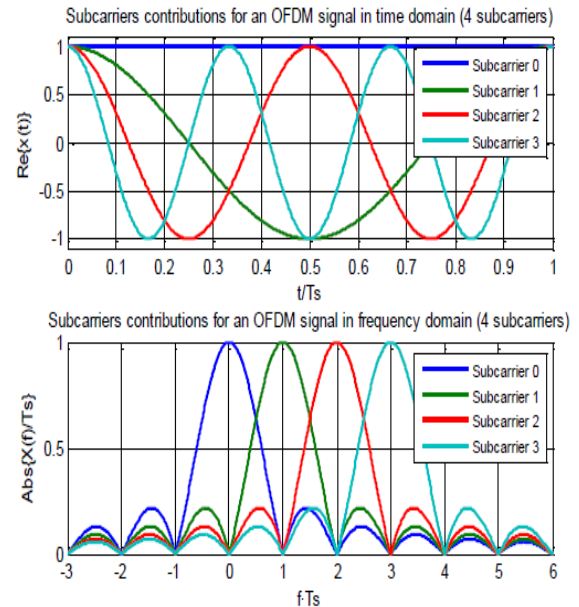

Figure-2. OFDM Subcarriers in time and frequency domains.

RF NON-LINEARITY IN OFDM TRANSCEIVER

In an OFDM communications system, nonlinearity is mostly caused by power amplifiers, A/D converters and Local Oscillators. Among these devices, power amplifiers produce a major nonlinearity due to the varying envelope of OFDM signal frames. One possible solution to this concern is to design highly linear amplifiers that have been under study for many years. Another solution is to reduce fluctuations of OFDM frame that goes through the RF power amplifier. In a typical scenario, OFDM frames are deteriorated due to clipping effect of the power amplifier operating in the non-linear region. The level of deterioration depends on the input back off (IBO) of the amplifier. In Figure-1, AM/AM characteristic of a power amplifier with associated input and output bakeoff's along with linear and nonlinear operation regions are displayed [6]. 1-dB compression point is usually given as the saturation point of the amplifier In general, IBO is chosen to be equal or higher than PAPR of the signal in order to avoid in-band and out-band interferences. However, high bakeoff values decrease amplifier efficiency and therefore reduce the battery life for the mobile device [15]. Since this high PAPR may degrade OFDM performance, BER and increase in the cost of the system and efficiency degradation especially at the transmitter side [8].
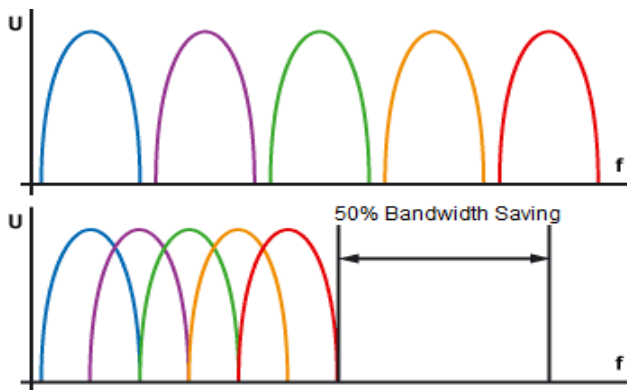
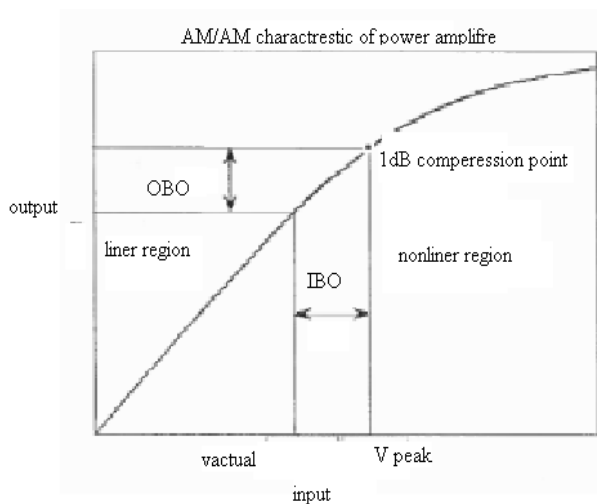www.arpnjournals.com

Figure-3. OFDM Bandwidth.

Figure-4. Output power amplifier characteristics.

PAPR IN OFDM

The PAPR in OFDM system can be significantly higher than the main power of the system. It is a swing of the instantaneous power with respect to the peak power. Further the PAPR rises with the number of sub- carrier N essentially. The higher PAPR in OFDM system rises because of the IFFT process at the transmitter end. [9], [2] Data symbols across subcarrier can add up-to produce a high peak value signal. High instantaneous swing with respect to the normal mean value. These peaks creates problem at different stages of OFDM system e.g. word length of IFFT/ FFT, DAC, ADC, and mostly the HPA. [3] Peaks caused HPA to operate in the saturation region. [11] Saturation creates both IB" in- band interference "distortion which causes BER increasing, and OB "out-of-band interference" distortion which leads to spectral widening and energy leakage to neighboring channels ICI that produce significant problem at OFDM receiver as there is Pone user from mobile terminal .If we use OFDM uplink we will loss transmit power. 4TH G is using the OFDM for down link but for up-link we should select

modulation in order to small battery be more efficiently operated. PAPR of 10dB means that for transmitting an average power of 0.2W the transmitter should be able to handle power peak of 2W [10 times higher]. The result is a very low efficiency or in other words high battery power consumption. PAPR can be described by its complementary cumulative distribution function (CCDF) [6]. The CCDF gives the probability that the PAPR value of the OFDM block exceeds a given threshold [10]. It is derived as:

$$PAPR\big(s(t)\big) = \frac{\max(|s(t)|^2)}{E\{|s(t)|^2\}} \qquad (2)$$

The PAPR OFDM sample [discretized signal] calculated from the equation

$$PAPR\big(s(t)\big) = \frac{\max(|X_k{}^2|)}{E\{|X_k|^2\}} \qquad (3)$$

Another parameter is the crest factor (CF),which is defined as the ratio between maximum amplitude of OFDM signal s(t) and root-mean square (RMS)of the waveform.[5] The (CF) is defined as [4]:

$$CF\big(s(t)\big) = \frac{\max[|s(t)2|]}{E\{||s(t)|^2|\}} \qquad (4)$$

In most cases the peak value of signal s (t) is equals to maximum value of its envelope o the signal .A number of attempts have been made to overcome the PAPR which can be considered as the main drawback of multicarrier transmission system which leads to power inefficiency in RF section of transmitter side. However none of them are reduce the PAPR and BER to an acceptable value. This paper focusing more on one of the most popular reduction techniques amongst signal scrambling techniques "Partial Transmit Sequence scheme" PTS which provided satisfactory results in OFDM system performance in term of reduce the complexity and PAPR. By investigating the impact of using generalized framework for DFT called GDFT.

Generalized Discrete Fourier Transform with Non-linear Phase provides a unity Framework where the linear phase DFT is extended to non-linear phase DFT. nonlinear phase by exploiting the phase space. Several applications where GDFT framework is employed to improve system performance will be discussed. As it is shown that GDFT offers significant performance improvements over PTS itself for PAPR reeducation in OFDM [15].

RELATED WORK

The PAPR problem attracts the researcher to find the radical solution to overcome it. Many schemes have been proposed especially with PTS technique as it provides good results that however until now the PAPR reduction at level 3.5 to 6 dB degradation [9]. [Ali A and Handan, 2009] they predict that GDFT "generalized DFT with nonlinear phase based OFDM which offered performance improvement. After that [10] from the theory of GDFT they applied GDFT in (PTS) Scheme. Pre distortion technique called complex gain memory pre distortion (CGMP) this technique enhanced (PTS) results in increasing in OFDM system efficiency and increased the battery life [8]. [3] another proposed technique which enhanced PTS to reduce the number of IFFT operation to half at a slight PAPR nonlinear phase is used with PTS to improve the performance of PTS scheme .the result shows reduces the number of the sunblock's for the same amount of PAPR reduction of the original PTS so they reduce the complexity however there is a side information needed. [14] proposed the DSI-PTS scheme the combination of DSI and PTS have been done and applied this scheme in WiMAX slandered reduced both the PAPR and complexity and decreased the time processing. A lot of work is done in the literature but still no one bring the PAPR and BER curve to an acceptable level.

PAPR REDUCTION TECHNIQUES

Several schemes have been introduced to achieve the PAPR reduction. These techniques can be divided into two categories: [1, 6].

a) Signal scrambling techniques
- Block Coding Techniques.
- Block Coding Scheme with Error Correction.
- Selected Mapping SLM.
- Partial Transmit Sequence PTS.
- Interleaving Technique.
- Tone Reservation TR.
- Tone Injection TI.

b) Signal distortion techniques
- Peak Windowing.
- Envelope Scaling.
- Peak Reduction Carrier.
- Clipping and Filtering.

SAGNAL SCRAMPLING

Different variation of codes used for scrambling category to achieve PAPR reduction such as: Barker codes, Sequences, Golay complementary and Shapiro – Rudin sequences. Main drawback is: As number of carrier increase the cost with search for best code increase exponentially. Better techniques amongst this category are Selective Mapping "SLM", which is in the frequency domain and Partial Transmit Sequences "PTS" which is in the time domain .Blok Coding. SLM Method applies scrambling rotation to all sub-carriers independently while PTS method only takes scrambling to part of the sub-carriers. [6] Signal scrambling with send side information to the receiver such as: block codes e.g. linear block code scheme, cyclic code scheme Probabilistic schemes: SLM scheme, PTS scheme, interleaving schemes. The disadvantages of this phase manipulation techniques reduces the effective throughput since they introduce the redundancy. Signal scrambling without send side information to the receiver: special block coding, Hadamard transform method, Dummy sequence insertion methods. Accordingly, each of the proposed techniques is related with a cost in terms of bandwidth or/and power.

SIGNAL DISTORTION

The signal distortion techniques introduce both in- band and out-of-band interference and complexity to the system. The distortion category attempts to reduce PAPR by changing some of signal characteristic before amplification. The simplest methods are Clipping and filtering of signal at the transmitter but due to non-linear distortion introduced by this process, orthogonality [8] is destroyed to some extent which results to increase in out-of –band (OOB) noise reduces the bandwidth efficiency also in-band interference cannot be removed by filtering, it decreases the bit error rate (BER)[1-2].Amongst this category better techniques: peak windowing, peak power suppression, peak cancellation, weighted multicarrier transmission [4]. This paper focusing more in PTS scheme for PAPR reduction as it has been used in our simulation.

PARTIAL TRANSMIT SEQUENCE SCHEM

PTS one of the effective schemes used for reducing PAPR in OFDM systems. PTS which is in time domain [8-9] classified under signal scrambling categories with explicit side information that should be transmuted to recover the original signal at the receiver side. Which reduces the effective throughput since they introduce the redundancy [1]. The need for transmission of side information can be overcome if differential modulation is employed for each sub block.

In the PTS Technique, the input OFDM symbol sequence is divides into a number of disjoint sub blocks, then IFFT is taken for each symbol subsequence and the resulting signal subsequences are summed after multiplying them by a set of distinct rotating vectors. Next the PAPR is computed for each resulting sequence and then the signal sequence with the minimum PAPR is transmitted. As the number of subcarriers and the order of modulation are increased, the system complexity is also greatly increased thus making this technique more complex in hardware implementation. For the sub-blocks portioning method of PTS techniques there has three known methods which are most frequently used: adjacent partition, interleaved partition, pseudo-random partition. In general, PTS scheme by using the pseudo-random

partition has better PAPR performance than other two methods. There are several methods which proposed to enhance the PTS scheme such as: conventional PTS (C-PTS) is a promising technique that can reduce the PAPR. Conventional PTS its complexity increase significantly as the number of sub blocks increases. [14] Dummy sequence insertion DSI-PTS is proposed and the complexity is decreased to the half, but the spectrum efficiency has degraded due to the additional of dummy sequences the. PTS with Sub Optimal Combination Algorithm which has less Computational Complexity and improve PAPR performance and no Optimization of phase factor.
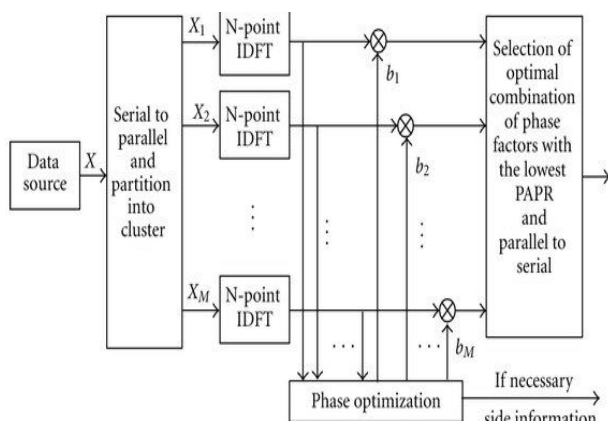
Figure-5. PTS in OFDM system.

FEATURES NEEDED FOR PAPR REDUCTION

Essentially a number of criteria have to take into account in evaluation of any PAPR reduction technique. But still no one gave acceptable results. For an acceptable technique, that technique must reduce the PAPR and BER significantly as well as the following performance factors must be considered for OFDM based system:[1] In this section have studied these factors with the PTS scheme to assessment   the performance of existing PTS schemes. The existing proposed techniques in terms of system requirements.

Table-1. Essential features in PAPR reduction technique with PTS method.

Factors	Evaluation of factors with PTS method of PAPR reduction
1. PAPR Reduction performance	Has good PAPR performance
2.Increase in transmit signal power	NO increase in transmit signal power [1]
3. BER increase at the receiver	Yes due to error inside information [3]
4. Less Bandwidth	A technique must not increase
Expansion	the bandwidth to value which causes degradation in the throughput" side information which increases bandwidth usage [11]
5. Data rates loss	The loss in data rate is due to transmission of side information utilizing some of the carriers.
6.Computational complexity	At transmitter processing [M] IFFT,WM, vector sums .At receiver [side information extraction inverse PTS]
7.Other consideration	PAPR reduction techniques can be used only after careful performance and cost analyses.

Therefore, careful attention must be paid to apply a proper technique for each communication system standard [6].

THEORY OF GENERALIZED DISCRETE FOURIRE TRANSFORM GDFT

Generalized Discrete Fourier Transform with Non-linear Phase provides generalization of the linear phase DFT is extended to non-linear phase DFT. There are infinitely many possible GDFT sets available in the phase space with constant power where can design the optimal basis. The availability of orthogonal constant amplitude transforms with good performance allows us to adaptive systems where user code allocations are made dynamically to exploit the current channel condition in order to deliver better communication performance and improve physical system security. Hence the basis functions of GDFT are defined as:

$$e_k(n) = e^{j\frac{2\pi}{N}\varphi_k(n).n} \qquad (5)$$

$k, n = 0, 1\ldots\ldots, N - 1$

N is dimensionality of the space is discrete time variable.

GDFT can be defined as the generalization to DFT based on the performance metrics related to the application under consideration. Hence, GDFT matrix is expressed as a product of two orthogonal matrices as follows: [15]

$$= A_{DFT}G$$
$$A_{GDFT}A_{GDFT}^{-1} = I$$
$$A_{GDFT}A_{GDFT}^{-1} = I \qquad (6)$$

Where the notation (*T) indicates that conjugate and transpose operations applied to the matrix and I is the identity matrix. Note that G is the complex orthogonal generalization matrix yielding AGDFT in equation (6) with the desired time and frequency domain features. Many of possible GDFT sets are available in the phase space which have constant power. That allows to design optimal basis. The rich library of orthogonal constant amplitude transforms with good performance allows us to design adaptive systems where basis assignments as well as code allocations are made dynamically and intelligently to exploit the current channel conditions in order to deliver better communications performance and improved physical layer security [16]. In the following paragraph, the GDFT framework is employed with PTS to improve system performance to reduce APAR in OFDM system.

INVESTIGATE OF GDFT BASED PTS SCHEME

GDFT-OFDM combines the advantage of GDFT with the traditional OFDM system, providing a new way to solve the problem of PAPR reduction in OFDM system. [16] This method modifying the phase of the input OFDM by using nonlinear phase of GDFT (GDFT pre – codded transmit data) before applying the original PTS algorithm. In this paper PTS with suboptimal combination algorithm has been used. This process leads to de-correlate the symbols of the input OFDM block consequently reducing the probability of producing high peaks of the amplitude when applying the IFFT on them. Also introduce an efficient selection method for PTS based on the Autocorrelation properties of the input signal vector feeding the multiplexer.   This scheme reduces the number of the sub blocks for the same amount of PAPR reduction. [10] PTS with a new phase sequence is generated, and is carried out by first generating the matrix of phase sequence and then partitioning it based on the requirement for PAPR reduction and complexity. This proposed technique with new phase sequence archives significant reeducation in the complexity of PTS by reducing the number of IFFT however that was at the expense of a slight PAPR degradation [9].The nonlinear

phase from the theory of Generalized Discrete Fourier Transform GDFT is used to achieve better performance of PTS.

PHASE OPTIMIZED GDFT BASED PTS

The probability of PAPR exceeding a threshold ɣ for OFDM symbols with the oversampling factor of L is shown as:

$$P\{PAPR > \gamma\} = 1 - [1 - \exp(-\gamma)]^{aN} \qquad (7)$$

Assume that M of OFDM symbols/frames corresponds to the same data sequence with different PAPR values. In this case, the probability of Equation (7) becomes:

$$P\{PAPR_{min} > \gamma\} = [P(PAPR > \gamma)]^M = 1 - [1 - \exp(-\gamma)]^{aN^M} \qquad (8)$$

The number of multiple signals is M = 2' and PAPR decreases as m increases. A simple way to generate multiple copies of the input data sequence by choosing M different vectors with the elements of complex roots of unity for each OFDM frame is also introduced in [15]. More specifically, the phase values for the elements of inverse DFT coefficient vectors are chosen as the integer multiples of π I 2 in their design. This method is extended by relaxing phase values of inverse DFT coefficient vector elements employing the GDFT framework. A special case for *G* matrix is expressed as

$$G(k,n) = \begin{cases} e^{j\frac{2\pi}{N}\varphi_i(n),} & k=n \\ 0 & k \neq n \\ k & n = 0,1,\dots,N-2 \end{cases} \qquad (9)$$
$$\varphi^i(n) = a_i n^{b_i} \quad a_i, b_i : Real \; n = 0,1,\dots,N1, \quad i = 0,1,\dots,M-1$$

As a special case, *a, =1* for *Vi* is picked, and the GDFT kernel is expressed as

$$A_{GDFT_i} = A_{DFT}G^i = \left[e^{j\frac{2\pi}{N}(kn+n^{b_i})}\right] \quad k,n = 0,1,\dots,N-1, \; i = 0,1,\dots M-1 \qquad (10)$$

The GDFT with minimum PAPR is identified along with the corresponding value of phase shaping function parameter k and the resulting OFDM frame is sent through the communications channel as displayed in Figure-6. The value of the parameter b, is also transmitted to the receiver as the side information. It is assumed that the receiver receives b, error-free and proceeds accordingly. The number of GDFT processors in Figure-6 depends on the number of side information bits to be transmitted per OFDM frame. For the case of m=3 bits, the number of inverse GDFT processors employed in the transmitter is M = 8. Selection of the phase parameters, b

is straightforward since the range of phase space is limited to the interval [0, 2 π] [15]. The number of diagonals is equal to $2^{m.}$ Selecting the optimal nonlinear phase vector is based on the autocorrelation properties of the phase – modified OFDM block. The autocorrelation is defined by the relation: [10]
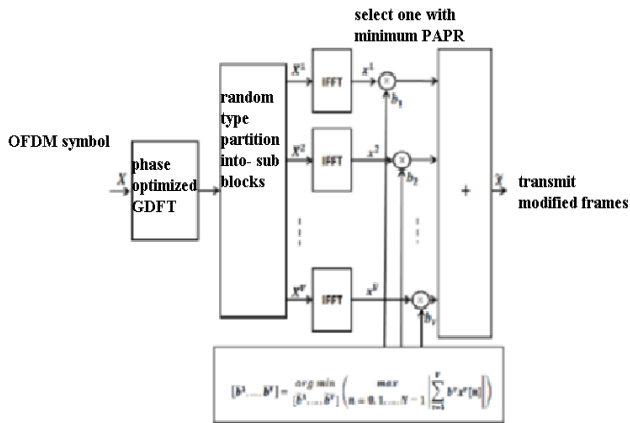
$$R_{yy}^i(m) = \sum_{k=-(N-1)}^{(N-1)} y^i(k)y^{*i}(k+m) \qquad (11)$$

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The result of $R_{yy}(m) = \sigma_m$ is compared with the optimal autocorrelation function with is an impulse represented as:

$$R_{yy}^{ideal}(m) = \delta_m \qquad (12)$$

The mean square error is used to choose the closest autocorrelation resulted value to the ideal autocorrelation.


Figure-6. Block diagram of phase optimized GDFT based PTS.

SIMULATION RESULTS AND DISCUSSIONS

The evaluation and composition of the performance of the original PTS and modified PTS with phase optimized GDFT are illustrated in this section. MATLAB has been used as simulation method. Simulation have been employed 16-QAM modulation with IFFT length of 64 and oversampled factor L=4to improve resolution, reduces noise and helps avoid aliasing and phase distortion by relaxing anti-aliasing filter performance requirements. To obtain the complementary cumulative distribution function [CCDF] 10000 random OFDM symbols are generated .PAPR increase with the number of subcarriers. Rate of increase slower after 64 subcarriers .PAPR increase with modulation order 64-QAM higher than QPSK and 256-QAN higher than 16-QAM. The CCDF curves of both original and modified PTS algorithm with random type of phase sequences is applied. When the number of the bits per -phase coefficient m=2 the performance of the modified PTS with V=1 is better with original PTS with V=2.where the cost of side information bits can be negligible also the implementation will be easier at the transmitter side.

Table-2. Simulation parameters.

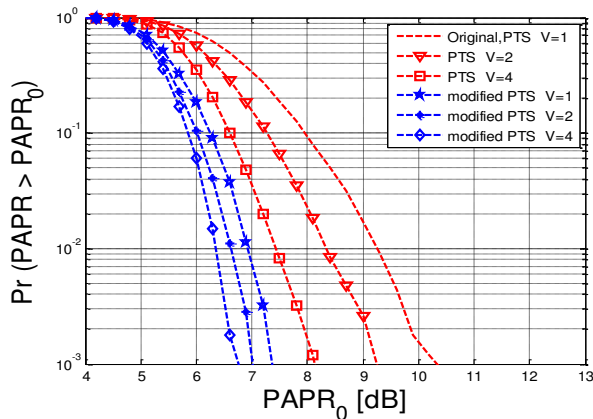| Parameter	Value
Number of side information bits m	0, 2, 3, 4, 6, 8, 10, 12
Number of PTS sub blocks V	1,2,4
Oversampling factor L	4
Number of transmitted OFDM blocks for iteration	10000
Number of subcarrier N	64,256,1024
Modulation schemes	QPSK,16-QAM,64-QAM,256 -QAM
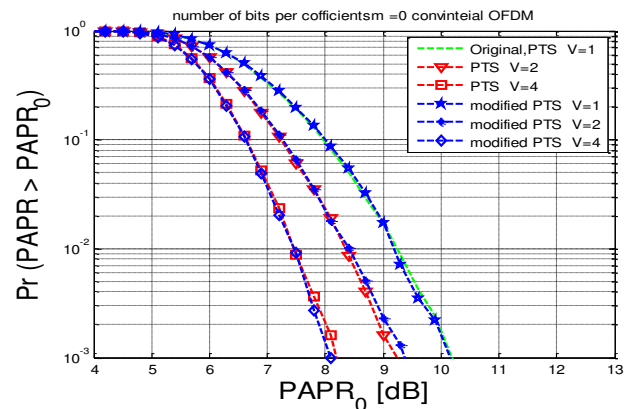
Figure-7. CCDF of PAPR for the Phase Optimized GDFT method using 16- bits per QAM symbol, numbers of side information m=0 bits and N=64(conventional PTS with Sub Optimal Combination Algorithm from this figure PAPR reduction with random phase sequence.
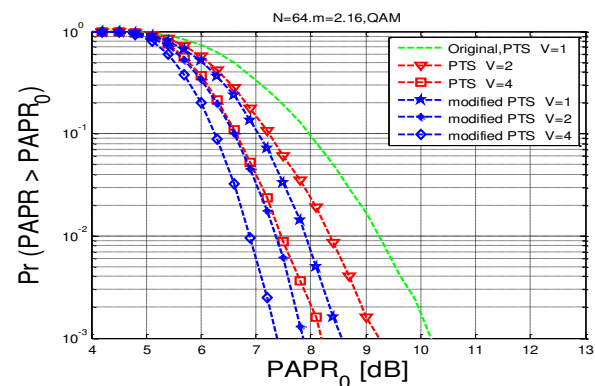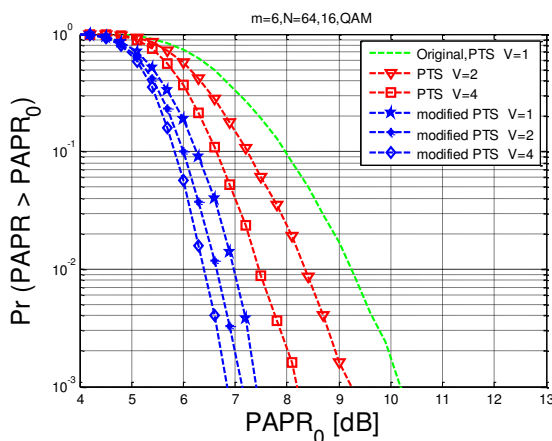

Figure-8. CCDF of PAPR for the Phase Optimized GDFT method using 16- QAM symbol, numbers of side information m=2 bits and N=64 from the simulation result 16-QAMwith m=2 give better Reproduction than QPSK with the same value of m.
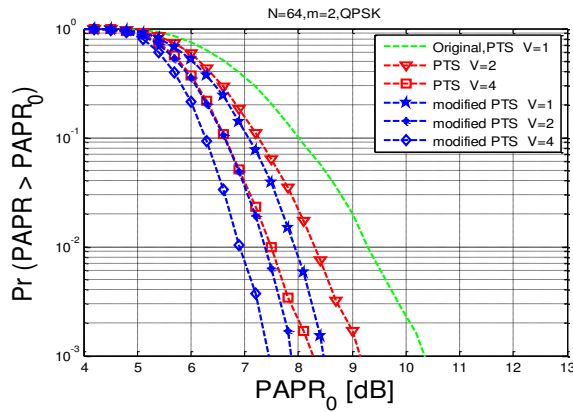
Figure-9. CCDF of PAPR for the Phase Optimized GDFT method using QPSK, numbers of side information m=2 bits and N=64.
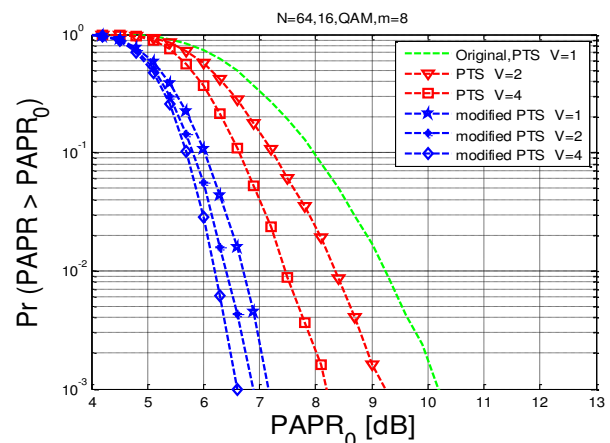
Table-3. PAPR (dB) for various side information bits, N=64.

Number of side information bits m	Number of PTS sub blocks V1,2,4	Size of OFDM block with modulation schemes 4 bits per symbol QAM	PAPR PTS GDFT$_{POT}$ [dB]
0			8
2		16- QAM	7.3
4			6.7
6			6.6
8			6.5
10			6.4
12			6.2

Figure-10. CCDF of PAPR for the Phase Optimized GDFT method using 16- bits per QAM symbol, numbers of side information m=3 bits and N=64.
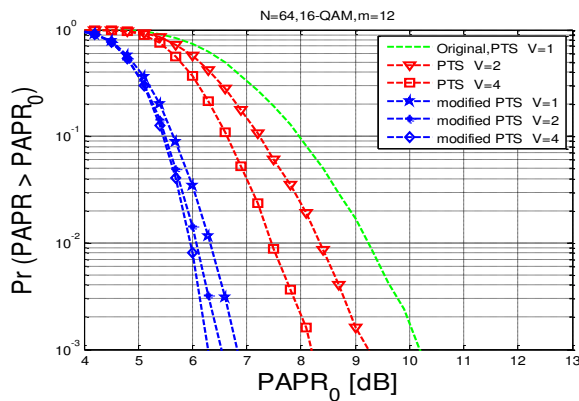

Figure-12. CCDF of PAPR for the Phase Optimized GDFT method using 16- bits per QAM symbol, numbers of side information m=8 bits and N=64.

Figure-11. CCDF of PAPR for the Phase Optimized GDFT method using 16- bits per QAM symbol, numbers of side information m=6 bits and N=64.
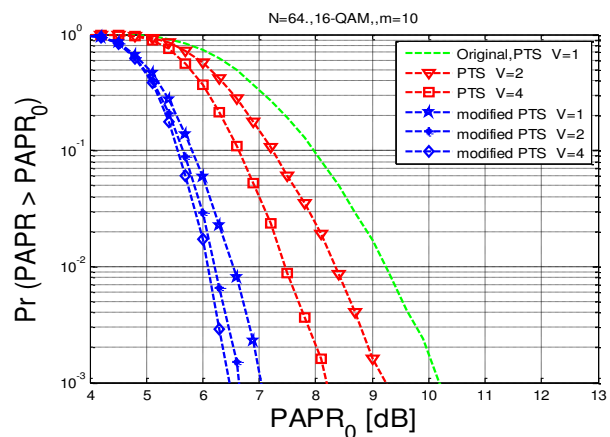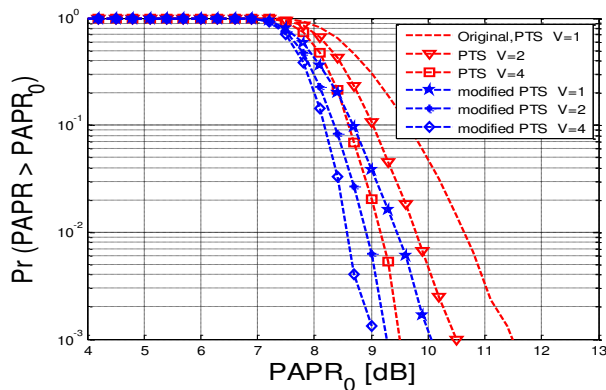

Figure-13. CCDF of PAPR for the Phase Optimized GDFT method using 16- bits per QAM symbol, numbers of side information m=10 bits and N=64 modified PTS with V=1 better than original PTS with V=4.

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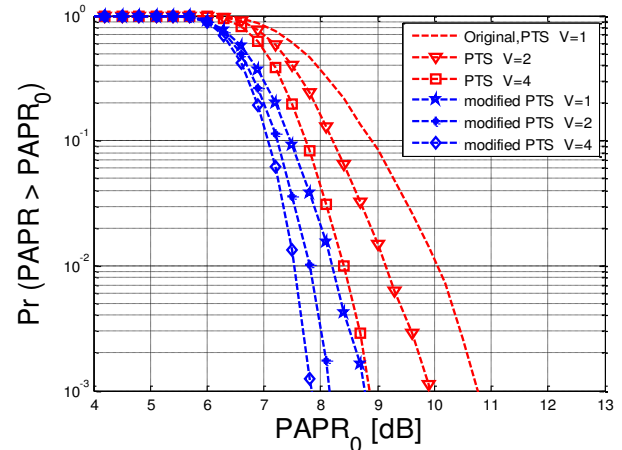

Figure-14. CCDF of PAPR for the Phase Optimized GDFT method using 16- bits per QAM symbol, numbers of side information m=12 bits and N=64.

It is observed from the figures that display CCDF of PAPR for different values of the numbers of side Information bits and 16-QM modulation for N=64, employing the Phase Optimized GDFT method. CCDF results are obtained using Equation (8). it is noticeable that as the number of side information bits increases PAPR reduction improves, in case of m=12 we have better performance compared with original PTS curve with v=1 and the reduction of PAPR is approximately 4dB.

Figure-15. CCDF of PAPR for the Phase Optimized GDFT method using 8 bits per QAM symbol, numbers of side information m=6 bits and N=1024 in this case modified PTS with V=1 better than original PTS with V=2.

Figure-16. CCDF of PAPR for the Phase Optimized GDFT method using 16- QAM symbol, numbers of side information m=6 bits and N=256 with increase the number of subcarrier PAPR increase also.
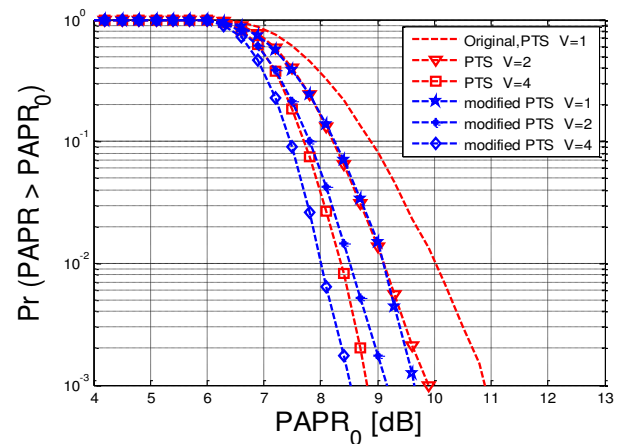
Figure-17. CCDF of PAPR for the Phase Optimized GDFT method using-256 QAM symbol, numbers of side information m=6 bits and N=256.

From Figures 16 and 17 PAPR reduction with 16-QAM outperforms the other modulation techniques 64 and 256 -QAM. However, in low-SNR channels, such as cellular and satellite, it is not possible to exchange the SNR/bit for bandwidth efficiency. Thus QPSK is widely used in satellite and cellular communication systems as it has better BER performance even though it has less PAPR reduction than 16-QAM.

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CONCLUSIONS

OFDM the most popular modulation and multiplexing technology for wireless communication applications. The researcher still continue to propose techniques for reduce the effects of PAPR problem in OFDM systems. A lot of work has done. However, still no one bring the PAPR and BER curve to an acceptable level. Several methods have been introduced with PTS techniques in order to reduce the complexity of the system and improve the performance in OFDM. This is concluded that Scrambling techniques give good performance but it needs side information for receiver to recover original data block, also it increases the complexity. The nonlinear phase of GDFT theory has been introduced to improve multicarrier communications performance of the PTS scheme to reduce PAPR in OFDM systems. Simulation illustrates modified PTS with phase optimized GDFT reduced the complexity with less number of sub block and PAPR when number of side information bits increased. Future work could focus more on the security purpose of using GDFT in wireless communication systems.

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