# PAPR REDUCTION IN OFDM SYSTEM USING PARTIAL TRANSMIT SEQUENCE BY DOMINANT TIME DOMAIN SAMPLES

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## Abstract

**The Orthogonal Frequency Division Multiplexing concept is based on spreading the data to be transmitted over a large number of carriers, each being modulated at a low rate. The carriers are made orthogonal to each other by appropriately choosing the frequency spacing between them. OFDM transmission system offers possibilities for alleviating many of the problems encountered with single carrier systems. It has the advantage of spreading out a frequency selective fade over many symbols. Partial Transmit Sequence is a Peak-to-Average Power Ratio reduction scheme for OFDM signals. High peak-to-average power ratio of OFDM signals results in signal distortion. This causes in-band distortion, out-of-band radiation and degrade Bit Error Rate at the receiver. OFDM needs a search to find minimum peak-to-average power ratio over all alternative OFDM signal vector. To reduce such complexity, peak-to-average power ratio value of all alternative OFDM signal vector is approximately calculated by using dominant time domain samples based on simple metric. Dominant time domain samples is selected first and it is sorted in the descending order of their metrics. The signal with minimum peak-to-average power ratio is transmitted with side information.**

**Index Terms: Metrics, OFDM, Partial transmit sequence, Peak -to-Average Power, Wireless communication**

## I. INTRODUCTION

The demand for multimedia data services has grown drastically which drive us in the age of fourth generation wireless communication system. This requirement of multimedia data service where user are in large numbers and with bounded spectrum, modern digital wireless communication system adopted technologies which are bandwidth efficient and robust to multipath channel environment known as multi-carrier communication system. The modern digital multicarrier wireless communication system provide high speed data rate at minimum cost for many users as well as with high reliability. In single carrier system, single carrier occupies the entire communication bandwidth but in multicarrier system the available communication bandwidth is divided by many sub-carriers. So that each sub-carrier has smaller bandwidth as compare to the bandwidth of the single carrier system. These tremendous features of multicarrier technique attract us to study Orthogonal Frequency Division Multiplexing (OFDM). OFDM forms basis for all 4G wireless communication systems due to its huge capacity in terms of number of subcarriers, high data rate in excess of 100 Mbps and ubiquitous coverage with high mobility. The necessity of high data rate draws the great attention in multi-carrier system. It should be capable to operate smoothly in environment of high carrier frequency, high data transmission rate and mobility. The studied has shown that OFDM fulfill the multicarrier system necessities. In single carrier (SC) system, one complex data is transmitted using one carrier and in this parallel transmission, complex data is transmitted over sub-carrier. Here the effective data rate of the system is same as of SC system. The parallel transmission increases the time period of symbol and the comparative amount of separation in time caused by multipath delay decreases.

In COFDM coded OFDM forward error correction (convolutional coding) and time/frequency interleaving are applied to the signal being transmitted. This is done to overcome errors in mobile communication channels affected by multipath propagation and Doppler effects. COFDM was introduced for Digital Audio Broadcasting . In practice, OFDM has become used in combination with such coding and interleaving, so that the terms COFDM and OFDM co-apply to common applications.

OFDM is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method. Numerous closely-spaced orthogonal sub-carrier signals with overlapping spectra are emitted to carry data. Demodulation is based on FFT algorithms. OFDM was improved with the introduction of a guard interval, providing better Orthogonality in transmission channels affected by multipath propagation Each sub-carrier (signal) is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase-shift keying) at a low symbol rate. This maintains total data rates similar to conventional single-carrier modulation schemes in the same bandwidth.

The main advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions

Channel equalization is simplified because OFDM may be viewed as using many slowlymodulated narrowband signals rather than one rapidly modulated wideband signal. The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to eliminate inter symbol interference (ISI) and utilize echoes and time-spreading (in analog television visible as ghosting and blurring, respectively) to achieve a diversity gain, i.e. a signal-to-noise ratio improvement. This mechanism also facilitates the design of single frequency networks (SFNs) where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be re-combined constructively, sparing interference of a traditional single-carrier system.

One key principle of OFDM is that since low symbol rate modulation schemes (i.e., where the symbols are relatively long compared to the channel time characteristics) suffer less from intersymbol interference caused by multipath propagation, it is advantageous to transmit a number of low-rate streams in parallel instead of a single high-rate stream. Since the duration of each symbol is long, it is feasible to insert a guard interval between the OFDM symbols, thus eliminating the intersymbol interference.

The guard interval also eliminates the need for a pulse-shaping filter, and it reduces the sensitivity to time synchronization problems.

A simple example: If one sends a million symbols per second using conventional single-carrier modulation over a wireless channel, then the duration of each symbol would be one microsecond or less. This imposes severe constraints on synchronization and necessitates the removal of multipath interference. If the same million symbols per second are spread among one thousand sub-channels, the duration of each symbol can be longer by a factor of a thousand (i.e., one millisecond) for Orthogonality with approximately the same bandwidth. Assume that a guard interval of 1/8 of the symbol length is inserted between each symbol. Intersymbol interference can be avoided if the multipath time-spreading (the time between the reception of the first and the last echo) is shorter than the guard interval (i.e., 125 microseconds). This corresponds to a maximum difference of 37.5 kilometers between the lengths of the paths.

The cyclic prefix, which is transmitted during the guard interval, consists of the end of the OFDM symbol copied into the guard interval, and the guard interval is transmitted followed by the OFDM symbol. The reason that the guard interval consists of a copy of the end of the OFDM symbol is so that the receiver will integrate over an integer number of sinusoid cycles for each of the multipath when it performs OFDM demodulation with the FFT. In some standards such as Ultra wideband, in the interest of transmitted power, cyclic prefix is skipped and nothing is sent during the guard interval. The receiver will then have to mimic the cyclic prefix functionality by copying the end part of the OFDM symbol and adding it to the beginning portion.

The OFDM concept spread the data over a large number of carriers, each is being modulated. The carriers are made orthogonal to each other It has the advantage of spreading out a frequency selective fade over many symbols. This effectively randomizes burst errors caused by fading or impulse interference so that instead of several adjacent symbols being completely destroyed; many symbols are only slightly distorted. This allows successful reconstruction of majority of them even without forward error correction. Because of dividing an entire signal bandwidth into many narrow subbands, the frequency response over individual subbands is relatively flat due to subband are smaller than coherence bandwidth of the channel. Thus, equalization is potentially simpler than in a single carrier system and even equalization may be avoided altogether if differential encoding is implemented. The orthoganality of subchannles in OFDM can be maintained and individual subchannels can be completely separated by the FFT at the receiver when there are no intersymbol interference (ISI) and intercarrier interference (ICI) introduced by the transmission channel distortion. Since the spectra of an OFDM signal is not strictly band limited, linear distortions such as multipath propagation causes each subchannel to spread energy into the adjacent channels and consequently cause ISI. One way to prevent ISI is to create a cyclically extended guard interval, where each OFDM symbol is preceded by a periodic extension of the signal itself. When the guard interval is longer than the channel impulse response or multipath delay, the ISI can be eliminated. By using time and frequency diversity, OFDM provides a means to transmit data in a frequency selective channel. However, it does not suppress fading itself. Depending on their position in the frequency domain, individual subchannels could be affected by fading. This requires the use of channel coding to further protect transmitted data. Coded OFDM combined with frequency and time interleaving is considered the most effective means for a frequency selective fading channel.

There are some obstacles in using OFDM in transmission system in contrast to its advantages. A major obstacle is that the OFDM signal exhibits a very high Peak to Average Power Ratio (PAPR).Therefore, RF power amplifiers should be operated in a very large linear region. Otherwise, the signal peaks get into non-linear region of the power amplifier causing signal distortion. This signal distortion introduces intermodulation among the subcarriers and out of band radiation. Thus, the power amplifiers should be operated with large power back-offs. On the other hand, this leads to very inefficient amplification and expensive transmitters. Thus, it is highly desirable to reduce the PAPR.

The other limitation of OFDM in many applications is that it is very sensitive to frequency errors caused by frequency differences between the local oscillators in the transmitter and the receiver. Carrier frequency offset causes a number of impairments including attenuation and rotation of each of the subcarriers and intercarrier interference (ICI) between subcarriers. In the mobile radio environment, the relative movement between transmitter and receiver causes Doppler frequency shifts; in addition, the carriers can never be perfectly synchronized. These random frequency errors in OFDM system distort orthogonality between subcarriers and thus intercarrier interference (ICI) occurs. A Number of methods have been developed to reduce this sensitivity to frequency offset.

In multi-carrier system, occupied bandwidth on the channel is minimized as possible. This minimization is possible by reducing the frequency space between carriers. The narrow space among the carriers is obtained when they are orthogonal to each other. To be orthogonal, the time averaged integral product of two signals should be zero.

## II. RELATED WORKS

There is a trade-off between the computational complexity and performance in the PAPR reduction method. The computational complexity reduction ratio increases as the number of subcarriers increases, the proposed scheme becomes more suitable for the high data rate OFDM systems such as a digital multimedia broadcasting system [1]. Selected mapping provides significant gains at moderate additional complexity. It is appropriate for all kinds of multiplex techniques, which transform data symbols to the transmit signal. Even in single carrier systems where PAR grows as the roll off factor of the pulse shaping filter decreases, selected mapping can be applied advantageously [6]. Various PAPR reduction schemes have been proposed such as clipping [6], Selected Mapping (SLM) [2], clipping [6], Partial Transmit Sequence (PTS) [16], Active Constellation Extension (ACE) [10], companding and Tone Reservation (TR) [21].

Among them, PTS and SLM schemes reduce the PAPR of OFDM signals effectively without causing any signal distortion. Compared with SLM schemes, PTS schemes require less inverse fast Fourier transform (IFFT) operations which increase the system implementation complexity. In the conventional PTS scheme, an input data vector is partitioned into several subblocks, which are separately IFFTed. Each of IFFTed subblocks is multiplied by phase rotating factor and then they are added together to produce an alternative OFDM signal vector. [1],[13],[14].

Recently, Combinatorial Optimization (CO) algorithms is used to simplify the search for the optimal phase rotating vector in the PTS scheme such as the simulated Anealing (SA) [18], the Particle Swarm Optimization (PSO-PTS) [13], the Artificial Bee Colony algorithm (ABC-PTS) [23]. Also, a low- complexity PTS schemes using sequences was proposed [9].

The reduced-complexity PTS (RC-PTS) [11] has been proposed to reduce the computational complexity by estimating the PAPRs of alternative OFDM signal vectors based on the selected dominant time-domain samples and find the alternative OFDM signal vector with the minimum estimated PAPR. Also, the improved PTSs have been proposed to further reduce the computational complexity and enhance the PAPR reduction performance of RC-PTS by using the dominant time-domain samples but different selection method for the dominant samples with RC-PTS.

## III. PROPOSED METHOD

Reduced complexity Partial Transmit Sequence method reduces the computational complexity. This scheme utilizes the correlation among the weighting phase factors. In this scheme, instead of decreasing the number of candidate signals, it focused simplifying the computation for each candidate signal. The proposed method generates a cost function by summing the power of the time-domain samples at time $n$ in each sub block. Only the samples with $Q_n$ greater than or equal to a preset threshold are used for peak power calculation during the optimization process.

The continuous-time OFDM signal in an $N$-subcarrier system can be represented as

$$x(t) = 1/\sqrt{N}\sum_{k=0}^{N-1} X_k e^{j2\pi k\Delta f t}$$

where $X_k$ is the data symbol carried by the $k$th subcarrier, $\Delta f$ is the frequency difference between adjacent subcarriers, and $T = 1/\Delta f$ is the symbol duration. The PAPR of $(t)$ is defined by

$$PAPR = \frac{max|x(t)|}{\sigma}$$

x$(t)$ can be sampled by the Nyquist rate $N/T$ to form the discrete-time OFDM signal which can easily be calculated by an $N$-point IFFT. Using this sampling process, we may miss the signal peak of $t$ and have an optimistic result for the PAPR. To estimate the PAPR from discrete-time samples, $L$ times oversampling is usually necessary for $(t)$.

Let $\mathbf{X} = [X_0, X_1, \cdot\cdot\cdot, X_{N-1}]^T$ denote an input data vector of length $N$ where $X_k$ is the input data symbol. Then the OFDM signal $x_n$ is calculated as

$$x_n = \frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} X_k e^{\frac{j2\pi kn}{N}}, \qquad 0 \le n \le N-1$$

and the PAPR of an OFDM signal vector $\mathbf{x} = [x_0, x_1, \cdot\cdot\cdot, x_{N-1}]^T$ is defined as

$$\text{PAPR} = \frac{max_{n=0}^{N-1}|x_n|^2}{E[|x_n|]^2}$$

In order to estimate N<sup>th</sup> PAPR of continuous-time OFDM signals, $L$-times oversampled OFDM signal is used. It is shown that $L = 4$ is sufficient to approximate the real peak of continuous-time OFDM signals. Also, the ratio of the maximum magnitude to the root mean square of the signal envelope is called the crest factor (CF) which is equivalent to the square root of PAPR as

$$CF=\sqrt{PAPR}$$

For large $N$, the OFDM signal $x_n$ can be modelled as a zero-mean complex Gaussian random variable and thus the magnitude of $x_n$ follows Rayleigh distribution. In order to analyse PAPR, it is convenient to check the complementary cumulative distribution function (CCDF) of PAPR, i.e., the probability that the PAPR of OFDM signals exceeds a given threshold $\delta$, which can be calculated as

$$P(PAPR> \delta)=1-(1-e^{-} \delta)^{\alpha N}$$

Where $\alpha$ is in general 2.8 from numerical analysis. Equivalently, by simply changing PAPR by CF, the CCDF of CF is also given as

$$P(CF>\sqrt{\delta}) =1-(1-e^{-} \delta)^{\alpha N}$$

In the conventional PTS scheme, an input data vector $\mathbf{Z}$ is partitioned into $M$ disjoint input data sub vectors $\mathbf{Z}_m = [Z_{m,0}, Z_{m,1}, \cdot\cdot\cdot, Z_{m,N-1}]^{T,}$ $0 \leq m \leq M - 1$, such that

$$Z = \sum_{m=0}^{M-1} Z_M$$

By applying IFFT to each $\mathbf{Z}_{m,}$ the OFDM signal sub vectors $\mathbf{Z}_m = [z_{m,0}, z_{m,1}, \cdot\cdot\cdot, z_{m,N-1}]^T$ are generated and each $\mathbf{x}_m$ is independently rotated by multiplying the phase rotating factor $b_m = e^{j\varphi m}$ where $\varphi m \in [0, 2\pi)$ for $m = 0, \cdot\cdot\cdot, M - 1$. In practice, the phase rotating factor $b_m$ is an element of the finite set given as

$$bm \in \{e^{j2\pi l/W} \mid l = 0, 1, \cdot\cdot\cdot, W - 1\}$$

Where W is the number of allowed phase rotating factors. Then, the phase rotating vectors are defined as $\mathbf{b}(u) = [b^{(u)}0, b^{(u)}1, \cdot\cdot\cdot, b^{(u)}M-1]$, $u = 0, 1, \cdot\cdot\cdot, U - 1$, and the u-th alternative OFDM signal vector $\mathbf{z}(u)$ is generated by

$$z^{(u)}=\sum_{m=0}^{M-1} b_m^{(u)} z_m \qquad u= 0,1,\ldots\ldots U-1$$

Where $U$ is the number of alternative OFDM signal vectors. Since all the phase rotating factors $b(0)m$ for the first sub block $\mathbf{z}0$ are fixed to 1, we have $U = W^{M-1}$. Finally, among $U$ alternative OFDM signal vectors, the optimal OFDM signal vector $\mathbf{z}^{(uopt)}$ with the minimum PAPR is selected and transmitted. Disadvantages of the conventional PTS are loss of data transmission rate due to the side information about $u_{opt}$ and large complexity. The side information [log2 $W^{M-1}$] bits for denoting the index of the selected phase rotating vector should be transmitted accompanying with the selected alternative OFDM signal vector. The computational complexity of the conventional PTS scheme mainly comes from $M$ IFFTs and the generation and PAPR calculation of $U$ alternative OFDM signal vectors.Figure 1 shows the block diagram of the proposed method.

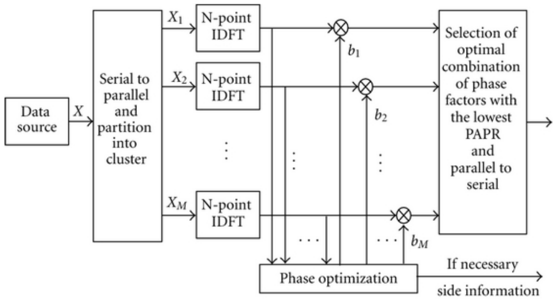

Figure 1.Block diagram of PTS

Fig 3.Block diagram of proposed PTS method

Main idea of PTS is data blocks are divided into non overlapping sub-block with independent rotation factor. This rotation factor generates time domain data with lowest amplitude. This is the modified technique of SLM which gives the better performance than SLM.

Partial Transmit Sequence (PTS) is one of the techniques used to reduce PAPR in OFDM system which is implemented in this paper. The fundamental idea of this technique is sub-dividing the original OFDM symbol data into sub-data which is transmitted through the sub-blocks which are then multiplied by the weighing value which were differed by the phase rotation factor until choosing the optimum value which has low PAPR.

The block diagram for PTS technique implementation is shown in figure. The data sequence X in frequency domain is sub-divided into $\boldsymbol{v}$ sub-sequence which were transmitted in sub-blocks without overlapping and having equal size of N which contains N/V non-zero values in each sub-blocks .With the assumption that the sub-blocks have equal size without having any gap between them.

In the RC-PTS scheme, more accurate PAPR estimation is achieved by using a smaller threshold $Th_Q$ because more time domain samples are selected, but it gives rise to an increase in the computational complexity. In this subsection, two new metrics are proposed by analysing the crest factor of alternative OFDM signal vectors, which enable the RC-PTS scheme to do better PAPR estimation with less dominant time-domain samples compared with the RC-PTS scheme using the metric Qn. To select the alternative OFDM signal vector with the minimum PAPR, the amplitude of the n-th sample for all alternative OFDM signal vectors should be calculated as follows

$$\left|\sum_{m=0}^{M-1} b_m^{(u)} z_{m,n}\right| = |z_n^{(u)}|$$

Since $|z^{(u)}n|$ clearly depends on the phase rotating vector $\mathbf{b}^{(u)}$. Now, two new metrics are proposed. The first proposed metric *Yn* is obtained by

$$Y_n = \sum_{m=0}^{M-1} |z_{m,n}|$$

In order to derive the second metric, $|z^{(u)}n|$ is rewritten as

$$|z_n^{(u)}| = \left|\sum_{m=0}^{M-1} b_m^{(u)} (Re\{z_{m,n}\} + jIm\{z_{m,n}\})\right|$$

Where Re{zm,n} and Im{zm,n} are the real and imaginary parts of zm,n, respectively. Then, the second metric An is defined as

$$A_n = \left|\sum_{m=0}^{M-1} (|Re\{z_{m,n}\}| + j|Im\{z_{m,n}\}|)\right| s$$

In case of W = 2, it is clear that $An \geq |z^{(u)})n|$ and An is equal to $\max_{u=0}^{U-1} |z^{(u)}n|$ when the signs of real and imaginary parts of the n-th samples of the M OFDM signal sub vectors **x**m are the same, respectively. However, if W > 2, $An \geq |z^{(u)}n|$ is not always true. Now, the sets of indices of the dominant time-domain samples selected by using the metrics Yn and An are defined as

$$\mathrm{P}Y = \{n \mid Yn \geq ThY\}$$

$$\mathrm{P}A = \{n \mid An \geq ThA\}$$

where *ThY* and *ThA* are the thresholds on *Yn* and *An*, respectively. The cardinality of **P***Y* and **P***A* is denoted by $|\mathbf{P}Y| = PY$ and $|\mathbf{P}A| = PA$, respectively. In general, the threshold is determined by considering the tradeoff between the computational complexity and the PAPR reduction performance. Note that only the dominant time-domain samples with the indices in **P***Y* or **P***A* are multiplied with the phase rotating factors are used to estimate the PAPRs of the *U* alternative OFDM signal vectors.

For further lowering the computational complexity of the low complexity PTS schemes without degrading the PAPR reduction performance, the selected dominant time-domain samples are sorted in decreasing order of their metric values as given below in the following equation by

$$\hat{\mathbf{P}}Y = \{p_0, \cdots, p_k, \cdots, p_{K_Y-1} \mid Y_{p_i} \geq Y_{p_{i+1}}, p_k \in \mathrm{P}Y\};$$

$$\hat{\mathbf{P}}A = \{q_0, \cdots, q_k, \cdots, q_{K_A-1} \mid A_{q_i} \geq A_{q_{i+1}}, q_k \in \mathrm{P}A\}.$$

Next, it will be explained how to further reduce the computational complexity only by using the sorted index sets $\hat{\mathbf{P}}Y$ and $\hat{\mathbf{P}}A$. For the first alternative OFDM signal vector, the power of each sample with the index in $\hat{\mathbf{P}}Y$ (or $\hat{\mathbf{P}}A$) is calculated in that order to estimate the PAPR. Then, denote the maximum sample power of the first alternative OFDM signal vector by $\gamma$. This $\gamma$ is compared with the power of each sample of the second alternative OFDM signal vector, which has the index in $\hat{\mathbf{P}}Y$ (or $\hat{\mathbf{P}}A$) in that order. For instance, $\gamma$ is compared with the power of $z(1)\,pk$. If the power of $z(1)\,pk$ is larger than $\gamma$, then stop calculating the power of the remaining samples and move to the third alternative OFDM signal vector to start the sample power calculation and comparison with $\gamma$ similar to the previous case. If the power of $z(1)\,pk$ is less than or equal to $\gamma$, then move to the next sample $z(1)\,pk+1$ to calculate the power and compare it with $\gamma$. If all the sample powers are smaller than $\gamma$, then $\gamma$ is updated with the maximum sample power of the second alternative OFDM signal vector and move to the third alternative OFDM signal vector to start the sample power calculation and comparison with $\gamma$ similar to the previous case.

This procedure is repeated until all alternative OFDM signal vectors are checked, the phase rotating vector giving the final value of $\gamma$ is selected, and the corresponding alternative OFDM signal vector is transmitted. Since the dominant time-domain samples are rearranged in decreasing order of their metric values, it is highly probable that samples with larger power are dealt earlier than those with smaller power. Let $\eta$ be the average number of samples to be compared with $\gamma$ until a sample with power bigger than $\gamma$ is found. It is clear that $\eta$ for the sorted case is much smaller than that for the unsorted case and therefore, the complexity of the proposed scheme is reduced by sorting the samples without performance degradation.

The proposed system is summarized as below

1) An input data vector is divided into $M$ disjoint subblocks and each of them is IFFTed.

2) Determine $\mathbf{P}_Y$ (or $\mathbf{P}_A$) .

3) If the proposed scheme without sorting in is used. Set $\gamma$ Otherwise, sort the elements.

4) Sort the elements in $\mathbf{P}_Y$ (or $\mathbf{P}_A$) in decreasing order of their corresponding metric values and denote it again as $\mathbf{P}_Y$ (or $\mathbf{P}_A$).

5) Set $\gamma$ as the maximum sample power among samples of the first alternative OFDM signal vector, which have indices in $\mathbf{P}_Y$ (or $\mathbf{P}_A$).

6) Each sample power having index in $\mathbf{P}_Y$ (or $\mathbf{P}_A$) of the second OFDM signal vector is compared with $\gamma$ . If a sample power is larger than $\gamma$ , stop calculating sample power and calculate the sample power for remaining alternative OFDM signal vector. Otherwise, $\gamma$ is updated by the maximum sample power of the second alternative OFDM signal vector and calculate the sample power for remaining alternative OFDM signal vector.

7) Calculate the sample power for remaining alternative OFDM signal vector for all the remaining alternative OFDM signal vectors and, the phase rotating vector giving the final $\gamma$ is usedto generate the optimal OFDM signal vector $\mathbf{Z}^{(u_{opt})}$

8) Transmit the optimal OFDM signal vector $\mathbf{Z}^{(u_{opt})}$ with the side information on $u_{opt}$.

## IV. RESULTS AND DISCUSSION

Orthogonal Frequency Division Multiplexing is a method of encoding digital data on multiple carrier frequencies. QPSK is a type of phase shift keying .QPSK is a Double Side Band Suppressed Carrier modulation scheme but it sends two bits of digital information a time without the use of another carrier frequency. The amount of radio frequency spectrum required to transmit QPSK reliably is half that required for BPSK signals, which in turn makes room for more user on the channel. For QPSK input bit stream need to break up to two –two bits and later these two bits are entered simultaneously to the input of the QPSK modulation. QPSK uses phase shifts of multiples of 90 degrees.

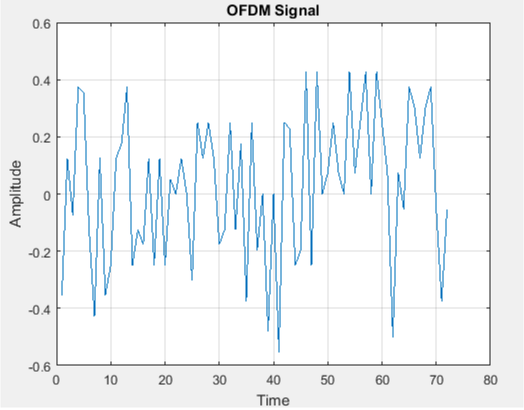

Figure 2.Generation of OFDM signal

The transmitted data phase representation of QPSK modulated OFDM signal is shown in figure. The data point is a discrete unit of information. In general any single fact is a data. A data point is usually represented numerically or graphically

Figure shows the transmitted data which is represented by a sequence of pulses bit means if a line code i.e., baseband transmission or by a limited set of continuously varying wave forms .Analog signal is digitized into bit-stream by using QPSK modulation.

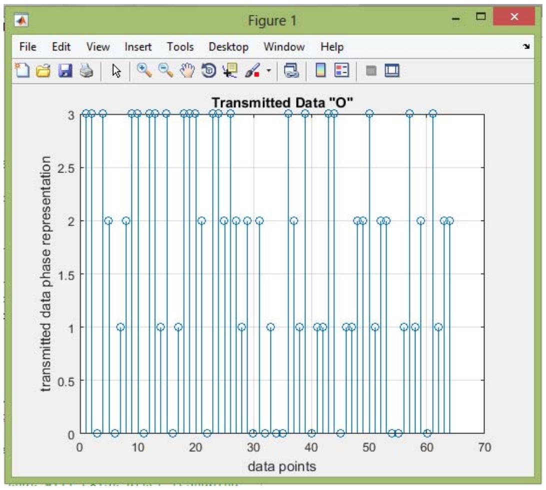

Figure 3. Transmitted data

Figure 4 shows the QPSK constellation of modulated transmitted signal. Each adjacent symbol only differs by one bit, sometimes known as quaternary or quadriphase PSK or 4-PSK or 4-QAM.QPSK uses four points on the constellation diagram, equispaced around a circle. With four phases, QPSK can encode two bits per symbol to minimize the BER twice the rate of BPSK.This yields the 4 phases. This result in a two dimensional signal space with basic functions. The first basis function is used as the in phase component of the signal and the second as the quadrature component of the signal. Hence the signal constellation consist of the signal space 4 points. X-axis corresponds to in-phase component and Y-axis corresponds to quadrature phase component.

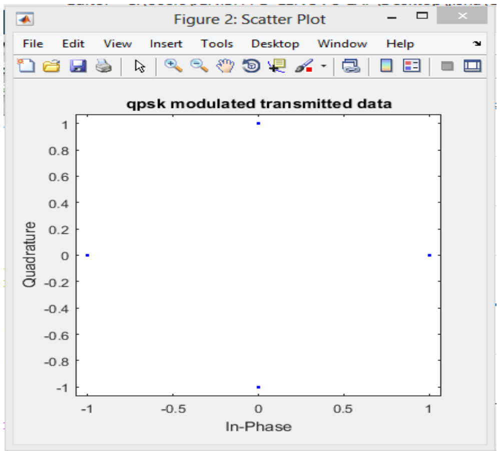

Figure 4. QPSK modulated transmitted data

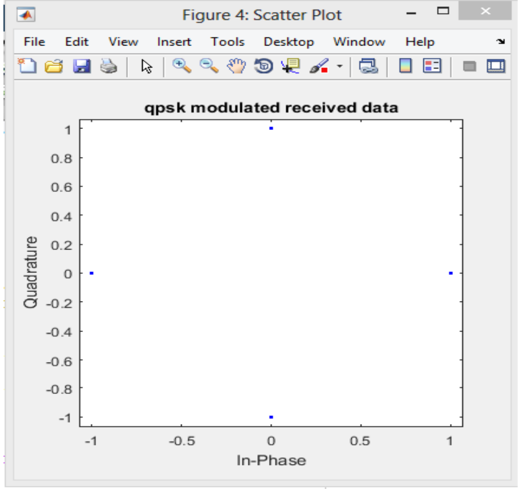

Figure 5.QPSK demodulated data

The data point is a discrete unit of information. In general any single fact is a data. A data point is usually represented numerically or graphically.

Figure shows the received data which is represented by a sequence of pulses bit means if a line code i.e., baseband transmission or by a limited set of continuously varying wave forms .Analog signal is digitized into bit-stream by using QPSK modulation.

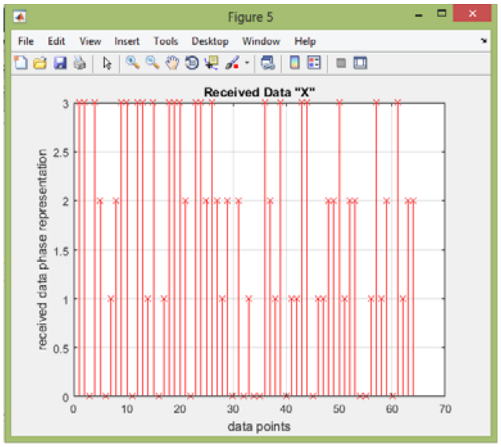

Figure 6.Received data

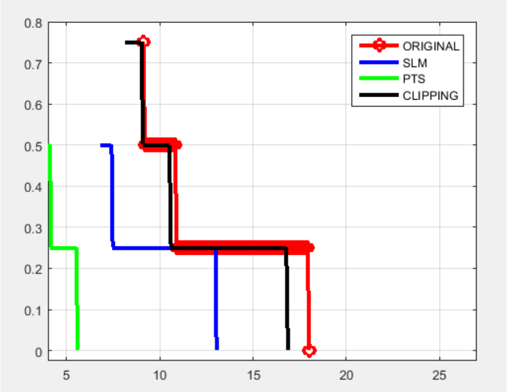

Figure 7.Comparison between various schemes

Below figure shows the comparison of OFDM signal and PTS in a semi log with Complementary Cumulative Distribution Function in vertical axis and Peak to Average Power Ratio in horizontal axis. The output power of the signal in PTS is very low when compared with OFDM signal without any algorithm. It is clear that the OFDM signal with Partial Transmit Sequence algorithm with low PAPR.

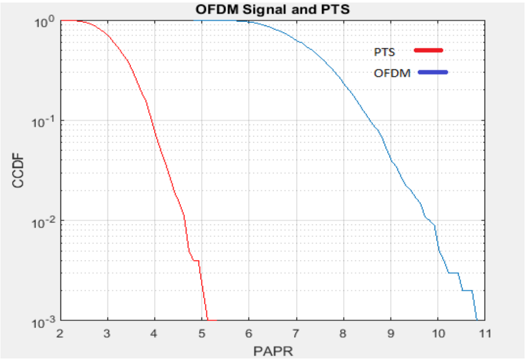

Figure 8. Comparison between OFDM signal and PTS

Figure 8 shows the comparison of OFDM signal and PTS in a semi log with Complementary Cumulative Distribution Function in vertical axis and Peak to Average Power Ratio in horizontal axis. The output power of the signal in PTS is very low when compared with OFDM signal without any algorithm. It is clear that the OFDM signal with Partial Transmit Sequence algorithm with low PAPR. An OFDM signal consists of a number of independently modulated subcarriers, which can give a large peak to average power ratio when added up coherently. This produces distortion in channel. Mostly nonlinear amplitude algorithm was used to reduce the PAPR of OFDM system. Figure shows the different modulation scheme used in PTS with PAPR value before and after clipping. It is clear that the PAPR value of QPSK modulation scheme has the low PAPR value after clipping. Hence it is an effective modulation scheme for PAPR reduction. Y-axis corresponds to the PAPR value in dB. Clipping is combined in PTS after modulation in order to reduce the PAPR value.

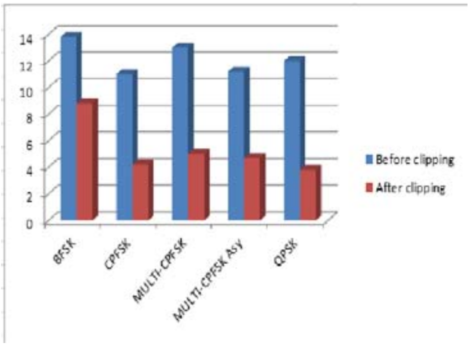

Figure 9. Different modulation schemes

Below figure shows the comparison of Phase sequence versus the over sampling factor. Also it gives the comparison of the algorithm such as OFDM signal without any algorithm, Selected Mapping and Partial Transmit Sequence. In OFDM signal the phase sequence used is 16 and there is no over sampling factor. As phase sequence decreases the over sampling factor increases. In SLM phase sequence used is 8 and over sampling factor is 1.this reduced to (4,4) in PTS i.e, phase sequence and over sampling factor is 4.

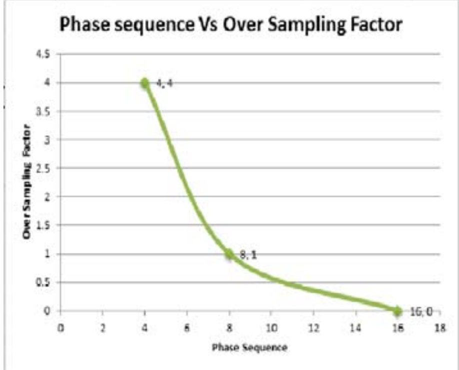

Figure 10. Comparison between phase sequence and over sampling factor

## V. CONCLUSION

Two effective metrics are derived to be used for selecting dominant time-domain OFDM signal samples and two low- complexity PTS schemes based on these two metrics are proposed. Two proposed metrics $A_n$ and $Y_n$ show very good PAPR reduction performance for $W = 2$ and $W = 4$, respectively. Furthermore, two proposed schemes using $A_n$ and $Y_n$ require much lower computational complexity to achieve the same PAPR reduction performance as the conventional PTS scheme. For more complexity reduction, sorting the selected dominant time-domain samples is proposed. Numerical analysis shows that the proposed PTS schemes using sorting achieve the same PAPR reduction performance as that of the conventional PTS scheme with substantially reduced computational complexity. Also, it is shown that compared with RC-PTS scheme, the proposed PTS schemes using sorting require much lower computational complexity while achieving the same PAPR reduction performance as that of the conventional PTS scheme.

In the present scenario, the PAPR problem is still challenging issue mostly for the devices where the minimization of linear range of power amplifier is importance. . This proposed system can be made more reliable by implementing a technique to recover the original signal in multipath environment with transmitting side information. Further enhancement on improving the complexity of the searching phase factors can be done. The proposed PAPR reduction technique can be applied with multiple input multiple output (MIMO) OFDM system.

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