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# A NEW SLM AND PTS SCHEMES FOR PAPR REDUCTION IN OFDM SYSTEMS

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**Abstract:** Orthogonal frequency division multiplexing (OFDM) is a multi carrier modulation technique where the revolution of 4G wireless communication is focused towards OFDM systems. The major drawback of OFDM system is high Peak to average power ratio .The proposed work is based on peak to average power ratio (PAPR) reduction by the implementation of Selective Mapping Technique (SLM) and Partial Transmit Sequence (PTS) methods. Further the work is extended by modifying the SLM and PTS of PAPR by reducing their complexity of the OFDM system. Simulation results show that the complexity is reduced by using newly proposed algorithm than normal schemes.

**Keywords:** OFDM , SLM , PTS ,CCDF

## I.INTRODUCTION

Nowadays the wireless applications are focused towards high data rates. The concept of multi carrier transmission provides high data rates in communication channel. The OFDM is a special kind of multi carrier transmission technique that divides the communication channel into several equally spaced frequency bands. Here the bit streams are divided into many sub streams and send the information over different sub channels. A sub-carrier carrying the user information is transmitted in each band. Each sub carrier is orthogonal with other sub carrier and it is carried out by a modulation scheme. Data's are transmitted simultaneously in super imposed and parallel form. The sub carriers are closely spaced and overlapped to achieve high bandwidth efficiency [2]. The main disadvantage of OFDM is high peak to average power ratio. The peak values of some of the transmitted signals are larger than the typical values [1]. High PAPR of the OFDM transmitted signals results in bit error rate performance degradation, inter modulation effects on the sub carriers, energy spilling into adjacent channels and also causes non linear distortion in the power amplifiers. The main work of this paper is to reduce the high peak powers in OFDM systems. Several methods are there to reduce PAPR effectively(15). In this study the concept of selective mapping (SLM)and partial tansmit sequence(PTS) technique is applied to the OFDM symbols to reduce high peak signals[11]. Coding and simulation were carried out for SLM, PTS and their effects on reducing the PAPR were analysed. Also Reduced Complexity approaches for the SLM and PTS techniques were carried out and their performances in reducing the PAPR were performed and analysed[3]. The power signals of all the above work are viewed in complementary cumulative distribution function (CCDF) plot. The results state that the proposed new SLM and PTS method attains a good PAPR reduction and the encoding complexity is reduced by applying the new schemes.

## II.SELECTIVE MAPPING TECHNIQUE (SLM)

Many methods are there to reduce the PAPR , but both complexity and redundancy are high and only small gains in PAPR are achieved[12]. When the phases of different sub-carriers add up in phase the possibility of PAPR being high is for sure. Hence one method to reduce the in-phase addition is to change the phase before converting the frequency domain signal into time domain[13]. Hence before taking the N point IDFT each block of input is multiplied by an φ vector of length N. Now there is a possibility that the PAPR may turn low.

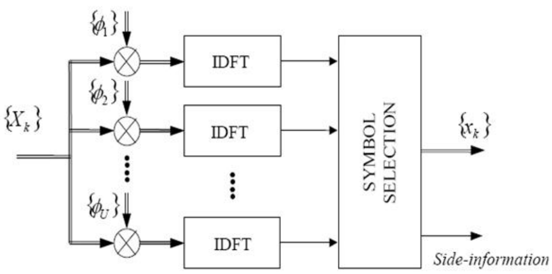


Fig 1 : Scheme of a Modulator with Selective Mapping

The figure 1 shows the scheme of a modulator with selective mapping technique. The algorithm for selective mapping technique is as follows:

Step 1: Get the input vector(X) of length D and let N=integer

Step2: for i=1: N

Step 2.1: Generate φ (i) of length D

Step 2.2: Multiply φ (i) with the input vector and

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get Z (Freq domain)
Step 2.3: Compute IDFT and get z (Time domain)
Step 2.4: Determine PAPR using the formula

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

Step 2.5: Increment the value of i
Step 3: Go-to Step 2
Step 4: PAPR of length N is obtained.
Step 5: Select a threshold Y. One with minimum PAPR is used for transmission
Step 6: If min of PAPR>Y then increment a count
Step 7: Perform Steps 1-6 M times
Step 8: Obtain final count
Step 9: Increment the value of N and repeat Steps1-8
Step 10: Plot Graph for various N values where
X axis: Threshold values
Y axis: Pr[PAPR low>Y]
Step 11: It could be inferred that as the value of N increases PAPR decreases
(It is required to inform the phase information controlled for the data sub-carriers to the receiver as side information)
Because of the varying assignment of data to the transmit signal, we call this 'Selected Mapping'. The core is to choose one particular signal which exhibits some desired properties out of 'N' signals representing the same information.

## III .PERFORMANCE ANALYSIS OF SLM

To evaluate and compare the performance of conventional SLM, computer simulation has been performed on an input sequence of length 8. Constellation of Binary phase shift keying (QPSK) is used as a signal mapper for OFDM system. For the conventional SLM, probability that, PAPR of an OFDM symbol exceeds an arbitrary threshold 'Y' is depicted below. The thresholds fixed are 1.5, 2, 2.3, 2.6 and 3.5. The experiment was repeated for over 1000 times.

### A.SIMULATION RESULTS FOR SLM

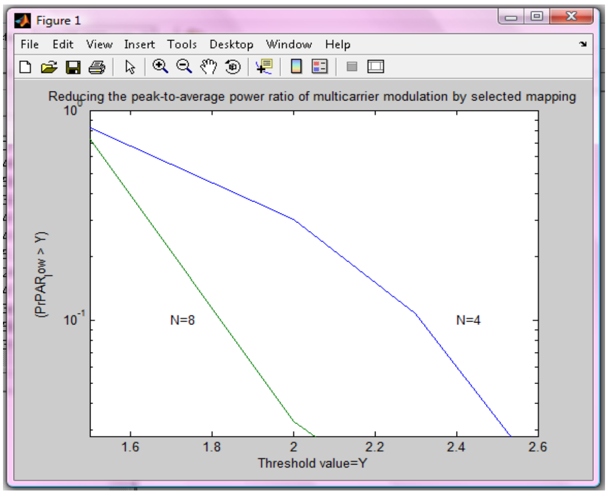


Figure 2: Simulated results for PAPR Reduction by Selective Mapping

Simulation was carried out for an input vector of length D=8. The algorithm was simulated for M=1000 times by varying the input vector which is a 4 QPSK mapped sequence. The output graphs were plotted for N=4 and N=8 as shown in fig 2.The threshold fixed are 1.5, 2, 2.3, 2.6 and 3.5. φ vector consists any of the values from +1,-1,+j, -j.

## IV. PARTIAL TRANSMIT SEQUENCES TECHNIQUE (PTS):

In the PTS approach, the input data block is partitioned into disjoint sub blocks or clusters which are combined to minimize the PAPR [5]. Define the data block,$[X_n, n=0,1\ldots\ldots N-1]$,as a vector ,$X=[X_0,X_1\ldots\ldots X_{N-1}]^T$. Then, partition *X* into *M* disjoint sets, represented by the vectors $[X_m, m=1,2\ldots\ldots M]$. The objective of the PTS approach is to form a weighted combination of the M clusters,

$$\mathbf{X}' = \sum_{m=1}^{M} b_m \mathbf{X}_m$$

Where $[b_m, m=1,2\ldots\ldots M]$ are weighting factors and are assumed to be pure rotations[6]. After transforming to the time domain, the above equation becomes

$$\mathbf{x}' = \sum_{m=1}^{M} b_m \mathbf{x}_m$$

The vector $\mathbf{x_m}$, called the partial transmit sequence, is the IFFT of $\mathbf{X_m}$**[7].** The phase factors are then chosen to minimize the PAPR of $\mathbf{x'}$. A PTS transmitter is shown in Fig 3.

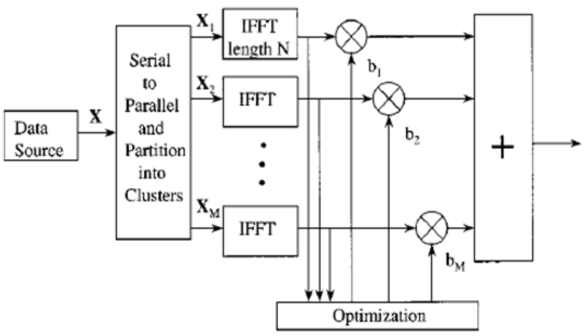


Fig 3: Scheme of a Modulator with Partial Transmit Sequences Technique

### A.PERFORMANCE ANALYSIS OF PTS

To evaluate and compare the performance of conventional PTS, computer simulation has been performed on an input sequence of length 32 that was sub-divided into 4 blocks each block of length 8 and also on an input sequence of length 64 that was sub-divided into 8 blocks each block of length 8. Constellation of Binary phase shift keying (QPSK) is used as a signal mapper for OFDM system[14].

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For the conventional PTS, probability that, PAPR of an OFDM symbol exceeds an arbitrary threshold Y is depicted in figure 4. The thresholds fixed are 1.5, 2, 2.3, 2.6 and 3.5. The experiment was repeated for over 1000 times.

### B.SIMULATION RESULTS FOR PTS

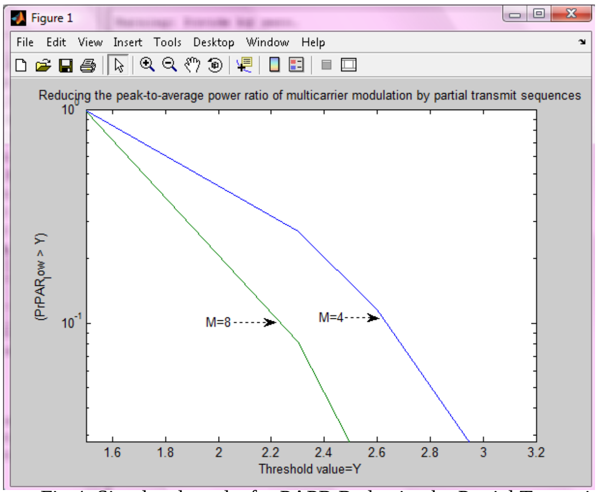


Fig 4: Simulated results for PAPR Reduction by Partial Transmit Sequences

The results described in figure 4 show that the sub-optimal iterative approach to combining PTS's provides significant improvement with only a small degradation compared to the expected. Nevertheless, the iterative approach requires feedback for implementation. An alternative approach, which avoids feedback, is to approximate the optimum by multiplying the information sequence by a random sequence and choosing the best to transmit.

## V. SIMPLIFIED METHODS FOR PAPR REDUCTION

### A. COMPLEXITY REDUCTION FOR SLM AND PTS:

This chapter presents a simplified version of partial transmit sequences (PTS) and selected mapping sequences to reduce peak-to-average power ratio (PAPR) of an OFDM signal. Simplification of PTS is achieved by having a set of partitions but optimizing phase values only for alternate partitions.

This proves to be a promising solution to reduce complexity of PTS. It is also proposed to choose the selected mapping sequences using a new phase Sequence[4]. In this previous case, although with an increase of the complexity, very high PAPR reduction can be achieved[10]. In the above two methods the complexity factor of the algorithm was quite high. This approach provides a trade-off between complexity and performance in SLM and PTS techniques[8].

### B.REDUCED COMPLEXITY SLM

In the case of reduced complexity SLM the φ vector is changed only of its odd components and the even components are assumed to be 1 for 1000 iterations. The other process remain the same.

### C. ALGORITHM FOR REDUCED COMPLEXITY SLM

Step 1: Get the input vector(X) of length D and let N=integer

Step2: for i=1: N

Step 2.1: Generate φ (i) of length D keeping the even values as 1.

Step 2.2: Multiply φ (i) with the input vector and get Z (Freq domain)

Step 2.3: Compute IDFT and get z (Time domain)

Step 2.4: Determine PAPR using the formula

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

Step 2.5: Increment the value of i

Step 3: Go-to Step 2

Step 4: PAPR of length N is obtained.

Step5:Select a threshold Y. One with minimum PAPR is used for transmission

Step 6: If min of PAPR>Y then increment a count

Step 7: Perform Steps 1-6 M times

Step 8: Obtain final count.

Step 9:To compare plot graphs for normal SLM and Reduced Complexity SLM

X axis: Threshold values

Y axis: Pr[PAPR low>Y]

Step 10: It could be inferred that reducing the complexity increases the PAPR.

### D.PERFORMANCE ANALYSIS:

To evaluate and compare the performance of Ordinary SLM and Reduced Complexity SLM, computer simulation has been performed on an input sequence of length 8. Constellation of Binaryphase shift keying (QPSK) is used as a signal mapper for OFDM system and φ € {±l, ±j}. For the conventional SLM and reduced complexity SLM, probability that, PAPR exceeds an arbitrary threshold Y is depicted below. The thresholds fixed are 1.5, 2, 2.3, 2.6 and 3.5. The experiment was repeated for over 1000 times.

### E.SIMULATED RESULTS FOR REDUCED COMPLEXITY SLM

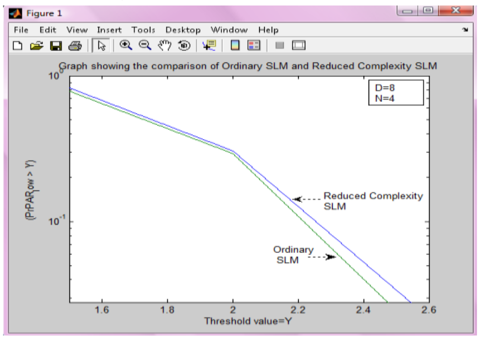


Fig 5: Simulated results for PAPR Reduction by Reduced Complexity SLM

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Simulated result showing a comparison in the PAPR performance for Ordinary SLM and Reduced Complexity SLM is shown in figure 5. Simulation results show that decreasing the complexity increases the PAPR.

### F.REDUCED COMPLEXITY PTS

In the case of reduced complexity PTS the 'W' vector is changed only of its odd components and the even components are assumed to be 1 for 1000 iterations. The other process remains the same.

### G.ALGORITHM FOR REDUCED COMPLEXITY PTS

Step 1: Get the input vector(X) of length D.
Step2: Divide the input vector into M blocks of length N where N=(D/M).
Step3: Assume a weight vector W of length M with initially given values as 1.
Step 4: Perform the N point IFFT on the M blocks and multiply with the weight vector.
Step5: Pass the output to a summer and obtain z (Time domain).
Step6: Determine the PAPR of z using the formula.

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

Let it be $PAPR_1$.
Step7: Now change the first odd value of the M length weight vector to -1 while the others remaining as 1.
Step8: Repeat Steps 4-5 and determine PAPR of z. Let it be $PAPR_2$.
Step9: If $PAPR_2 < PAPR_1$, then retain the weightvector, else change the next odd value to -1.
Step10: Repeat the Steps until the weight vector with minimum PAPR is obtained. Note that the even values in the weight vector should always be 1.
Step 11: PAPR vector of length M is obtained.
Step 12: Select a threshold Y
Step 13: If min of PAPR>Y then increment a count
Step 14: Perform Steps 1-13 K times by changing the input vector and keeping N the same.
Step 15: Obtain final count
Step 16: To compare plot graphs for normal PTS and Reduced Complexity PTS
X axis: Threshold values
Y axis: Pr[PAPR low>Y]
Step 17: It could be inferred that reducing the complexity increases the PAPR.

### H.PERFORMANCE ANALYSIS

To evaluate and compare the performance of Ordinary PTS and Reduced Complexity PTS, computer simulation has been performed on an input sequence of length 32 divided into 4 sub-blocks each of length 8. Constellation of Binaryphase shift keying (QPSK) is used as a signal mapper for OFDM system and W € {±l}[9]. For the conventional PTS and reduced complexity PTS, probability that, PAPR exceeds an arbitrary threshold Y is depicted in figure 6. The thresholds fixed are 1.5, 2, 2.3, 2.6 and 3.5. The experiment was repeated for over 1000 times.

### I.SIMULATED RESULTS FOR REDUCED COMPLEXITY PTS

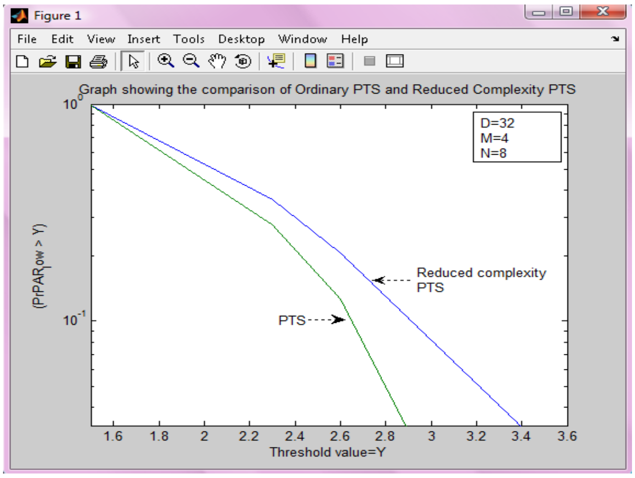


**Fig 6 :** Simulated results for PAPR Reduction by Reduced Complexity PTS

## VI. CONCLUSION

The simulation result shows that the ordinary SLM and PTS have better PAPR reduction but the complexity is more. The proposed new scheme reduces the complexity of the OFDM systems as the PAPR increases. The work can be extended by applying the same procedures for other PAPR reduction schemes.

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