PAPR ANALYSIS IN OFDM SYSTEMS USING PTS REDUCTION TECHNIQUE

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***Abstract* - Orthogonal Frequency Division Multiplexing (OFDM) is a promising technology for wireless communications, which is one of Multi-Carrier Modulation (MCM) techniques. It is one of the important candidate for high data rate communications. High Peak-to-Average Power Ratio (PAPR) of transmitted signals is one of the main problem in OFDM. The high PAPR results some interference to the system. This paper analyses the reduction of the PAPR using PAPR reduction technique called Partial Time Sequence (PTS) with different sub block and comparison between the PAPR of the OFDM system with and without this reduction technique.**

Keywords: OFDM,PTS,BW

I .INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a method of Digital Modulation. In OFDM, the signal is split into several narrowband channels at different frequencies. It is the one of the important candidate for the 4G communication. The main idea behind the OFDM is that it divides the frequency spectrum into sub-bands. A large number of closely spaced orthogonal sub carriers are used to carry data. Then the data are divided into several parallel data streams or channels, one for each sub carrier. Each sub carrier is modulated with a conventional modulation scheme such as Quadrature Amplitude Modulation (QAM) or Phase Shift Keying (PSK) at a low symbol rate. The total data rate is to be maintained similar to that of the conventional single carrier modulation scheme with the same bandwidth.

Since the presence multiple carriers leads implementation problems. The major one is the high Peak to Average Power Ratio (PAPR) of OFDM systems. In OFDM the system output is the superposition of the multiple carriers, it leads the instantaneous power of the signal increases as compared to the average power of the system. For practical OFDM systems, the high power amplifier (HPA) is used to amplify the signals. But the OFDM with high PAPR is very difficult to amplify by means of HPA ,because of its limited linear range. Thus, OFDM signals with high PAPR could be seriously distorted by the non linearity of HPA, resulting some additional interference into the system. If IBO increases, PAPR can be reduced. The higher IBO leads some in band and out band distortions .So only possible solution is to reduce the PAPR is to use some PAPR reduction techniques. Recently, a promising technique for improving the statistics of the PAPR of OFDM signals has been proposed: the partial transmit sequence (PTS) technique.

II. PEAK TO AVERAGE POWER RATIO

The OFDM signal consists of sum of many sub carriers. These sub carriers are modulated by using phase shift keying (PSK) or quadrature amplitude keying (QAM). In OFDM, N number of such symbols are then fed to IDFT or IFFT through serial to parallel converter where N is number of sub carriers. If $s_0,s_1,\ldots.s_{n-1}$ are N complex QAM (or PSK) symbols, then output of the IDFT or IFFT is given as

$$X(t)=\frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} S_K e^{2\pi tk/N} \quad \text{I} \quad \ldots\ldots\ldots(1)$$

where t=0,1,2,…N-1

Due to the occurrence of a large number of independently modulated sub carriers, the peak value of the system become very high as compared to the average of the system. The ratio between these two are called peak to average power ratio. The PAPR of a system is given by:

PAPR=Max instantaneous power/average power

$$PAPR = \frac{\max |x(t)|^2}{1/NT\int |x(t)|^2 dt} \quad \ldots\ldots\ldots\ldots(2)$$

reducing the max|x(t)| is the principle goal to reduce the PAPR. There are several techniques to reduce the PAPR. The most commonly used techniques are the 'Selected Mapping (SLM)', 'Clipping', 'Amplitude filtering', 'Interleaving', etc. But it leads to increased BER, higher complexity, transmit signal power increase, loss of data rate, and so on. One promising solution to reduce PAPR is Partial transmit sequence, which overcomes the shortcomings of other techniques.

III. PARTIAL TIME SEQUENCE METHOD

Partial Transmit Sequence (PTS) algorithm is one of the distortion less based PAPR reduction technique. The basic idea of Partial Transmit Sequences algorithm is to divide the original OFDM sequence into several sub sequences and for each sub sequences multiplied by different weights until an optimum value is chosen. Different weight is nothing but the different phase sequences. The commonly used phase sequence are the {+1,-1,+j and –j}.Fig 1 shows the block diagram of PTS. In PTS approach, the input data block is partitioned into no of disjoint sub-blocks. The sub-carriers in each sub-block are weighted by phase rotations. The phase rotations are selected such that the PAPR is minimized. Then at the receiver side the original data are recovered by applying inverse phase rotations. In order to implement this idea, the input data block of K symbols is divided into M disjoint blocks X_k, k =1, ...,M. Each block of same size. All sub carrier positions in X_k, which are already represented in another sub block, are initialized to zero, so that

$$X=\sum_{k-1}^{M} X_k \quad \ldots\ldots\ldots\ldots(3)$$

Each sub-block is weighted by a set of rotation factors $bk(v)$ where $u = 1.....U$, then the modified subcarrier vector

$$X^p = \sum_{k-1}^{M} X_k b_k(v) \quad \ldots\ldots(4)$$

is obtained, The phase factors are selected such that the PAR of the combined signal is minimized.

Mathematically, it is expressed as:

$\{b_1(v),b_2(v)\ldots b_M(v)\}=$

$\text{argmin}(\max_{0\le n\le N} \left| \sum_{k-1}^{M} IDFT(X)\, b(v) \right|)$

Where,

$$b_u(v)=e^{j\emptyset(v)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$\emptyset(v) \in (0,2\pi) \quad \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Resulting in the optimum transmit sequence

Ie,

$$X^p(v_{opt})= \sum_{k-1}^{M} IFFT(X_k)\, b_k(v) \quad \ldots\ldots\ldots(6)$$

Where is the phase vector that gives the greater reduction.

The *argmin(.)* is the judgment condition that output the minimum value of function.*arg* determines the argument function. In this way we can find the best **b** so as to optimize the PAPR performance.

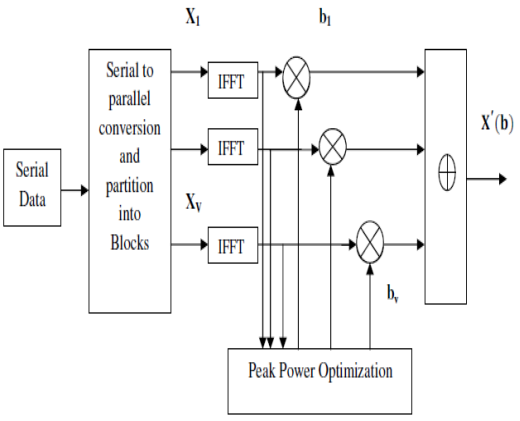

Fig.1.Block diagram of PTS

The main steps in PTS are data input block is partitioned into sub-blocks, representing certain portion of the actual information. Then the sub-blocks are passed on to IFFT and multiplied by a corresponding phase value and then added up to get the output signal whose PAPR will be comparatively less. Binary Phase Shift Keying (BPSK) or Quadrature Phase Shift Keying (QPSK) or Quadrature Amplitude Modulation (QAM) is used to modulate the input and the modulated signal as input for the proposed block diagram of PTS.

IV. SIMULATION RESULTS

Partial Time Sequence is one of the efficient method for the PAPR reduction in OFDM system. Here the total number of sub carriers are taken as 64 and the signals are modulated by means of QPSK modulation technique .And the modulated data are divided into 4 and 8 sub blocks ,each sub block then undergoes some IFFT operations .IFFT provide the modulation and multiplexing in a single step. As compared to DFT,IFFT provide efficient result with less complexity. Each of the signals are then multiplied with the phase rotation factors such as {+1,-1,+j,-j}. Then the signals are combined and choose the signal with minimum PAPR are transmitted over AWGN channel. With the simulation results of PAPR reduction of OFDM system without PTS, simulated work is concluded in the way, QPSK modulation scheme used in OFDM simulation.. The no of sub-carriers is N=64 with SSPA amplifier of IBO 3. PAPR0 of the original OFDM is computed by over sampling the no. of sub-carriers N=64 by the over sampling factor of L=4 .The PAPR of the signal obtained here is about 10.8 dB which is shown in fig 2

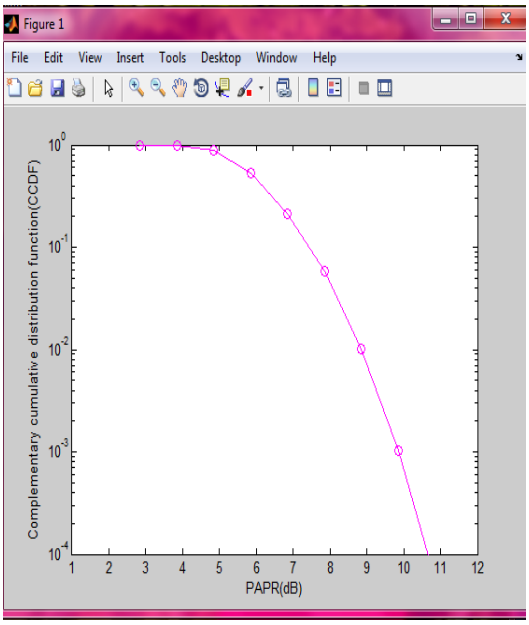

Fig 2 PAPR without PTS

Fig 3 shows the simulation curve of PTS technique for the number of subcarrier *N*=64 and the data is transmitted using different number of sub-blocking factor. *V* takes the value of 4. When we use sub block factor value *V*=4 then the PAPR value of the signal is about 7.7 dB which is 3.1 dB smaller than the original signal.

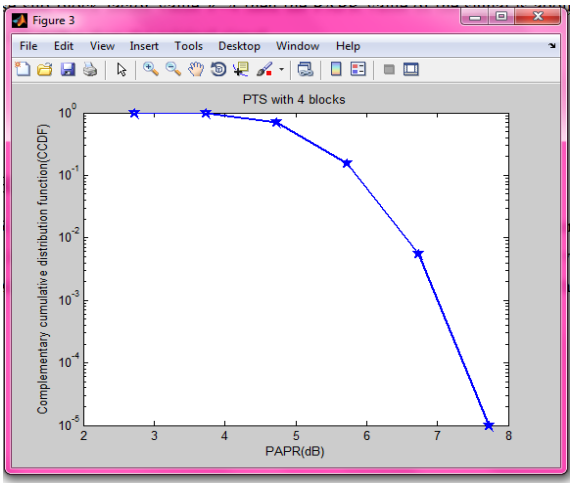

Fig 3 PTS with 4 blocks

Fig.4. shows the simulation curve of PTS technique for the number of subcarrier *N*=64 and the data is transmitted using different number of sub-blocking factor *V* takes the value of 8.

Then the PAPR value of the signal is about 4.2 dB which is 6.6 dB smaller than the original signal.

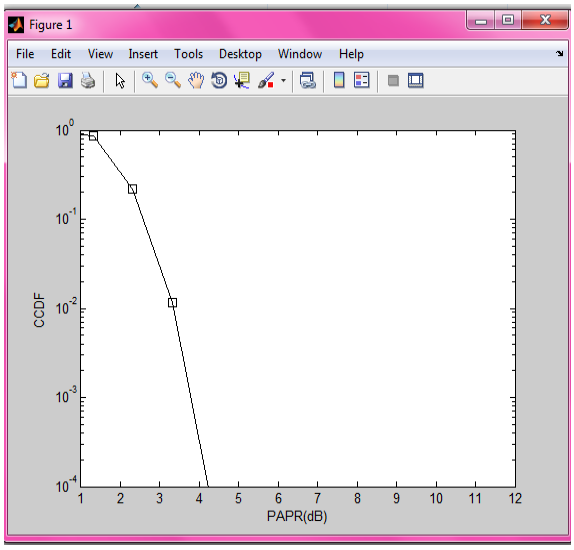

Fig 3 PTS with 8 blocks

Fig.4.represents the graph which may obtained by combining all the PAPR with out and with PTS technique

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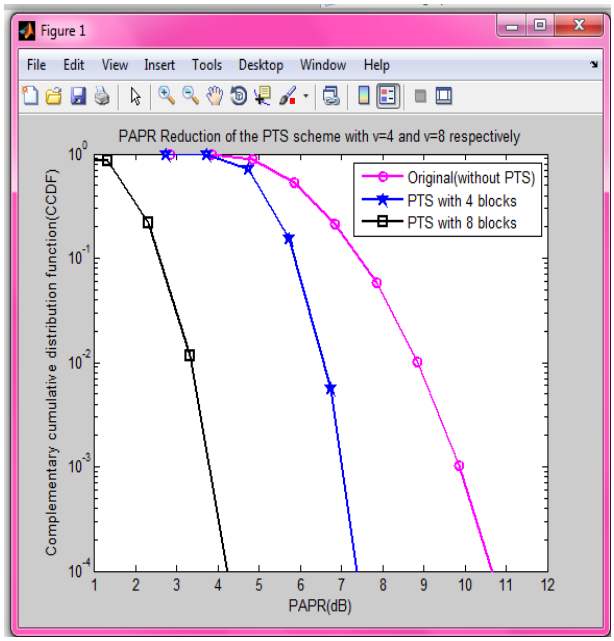

Fig 4 PAPR analysis

V. CONCLUSION

The effect of the PAPR reduction in OFDM systems with Partial Time Sequence has been carried out successfully. There are several techniques to reduce the PAPR in OFDM transmission system. All PAPR reduction techniques have advantages and limitations. PTS technique can significantly improve the reduction of PAPR problem. Success of PTS technique depends on the number of sub-blocks and the number of possible phase values. This project analyzed the PTS technique for different number of sub-blocks and compare the PAPR in the OFDM system with and without any reduction technique. The simulations show that PAPR reduced when the number of sub-blocks are increases. By using PTS technique with number of sub-blocks of four the PAPR value of the signal is about 7.2 dB which is 3.6 dB smaller than the original signal . When the number of sub-blocks of eight then the PAPR value of the signal is about 4.2 dB which is 6.6dB smaller than the original signal .Its shown that by increasing the no. of sub blocks the PAPR get reduced as compared to the original signal.

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