Efficient Use of PTS for PAPR Reduction in OFDM System

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***Abstract*— Orthogonal Frequency Division Multiplexing (OFDM) is an eminent technology in wireless communication. High peak-to-average power ratio (PAPR) is a challenging issue in OFDM system. Partial Transmit Sequence (PTS) technique is an illustrious technique to reduce PAPR. In this work we efficiently apply PTS technique to reduce PAPR. And the simulation results show that the proposed techniques have better PAPR reduction performance than conventional Partial Transmit Sequence technique.**

***Keywords*— OFDM, PAPR, PTS, CCDF, IFFT, HPA**

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is an attractive technology for wireless communication [1]. OFDM based systems are widely used for wireless applications. The main idea in OFDM is the use of narrow band subcarriers. Instead of using a single wide band subcarrier OFDM uses multiple narrow band subcarriers for data transmission.

A large number of closely spaced orthogonal subcarriers are used to carry data. The orthogonality of the carriers means that each carrier has an integer number of cycles over a symbol period. And the spectrum of each carrier has a null at the center frequency of each of the other carriers in the OFDM system and results in no interference between the carriers. This allows the carriers to be spaced as close as possible. And thus the spectral efficiency is improved. In OFDM the data to be transmitted is divided into several parallel data streams, one for each of the subcarriers. The subcarriers are modulated with a conventional modulation scheme such as Quadrature Amplitude Modulation (QAM) or Phase Shift Keying (PSK) at a low symbol rate. And in OFDM the total data rate is maintained similar to that of the conventional single carrier modulation scheme with the same bandwidth. Orthogonal Frequency Division Multiplexing is a promising technique for achieving high data rate and combating multipath fading in Wireless Communications. OFDM is a special form of multicarrier modulation which is particularly suited for transmission over a dispersive channel. Here the carriers are orthogonal to each other. That is the carriers are totally.

independent of one another. One of the major challenging issues of OFDM is high peak-to-average power ratio [2, 10], which is defined as the ratio of the maximum instantaneous power and its average power. OFDM signal has very wide range of amplitudes with high PAPR. Therefore HPA will introduce additional interference and inter modulation between the different carriers. The additional interference leads to an increase in BER.

In order to reduce the signal distortion and BER, HPA requires a linear work in its linear amplifier region with large dynamic range. But the linear amplifier has poor efficiency and is so expensive. Large PAPR also demands the DAC with enough dynamic range to accommodate the large peaks of the OFDM signals.

The major disadvantage of OFDM technique is its high peak-to-average power ratio [6]. To overcome this problem, a number of techniques have been proposed over the past decade, including clipping[3], block coding, active constellation extension (ACE) , tone reservation (TR) , tone injection (TI) , companding transform schemes and multiple signal representation techniques such as partial transmit sequence (PTS) and selective mapping (SLM)[2].

Selected Mapping (SLM) is an efficient method for peak-to-average power ratio reduction in OFDM systems [5]. In Selected Mapping technique the data sequence is multiplied with each phase sequences generated. And thus different sequences which carry same information are formed [9]. From these the signal with minimum PAPR is selected for transmission [6]. The major disadvantage of SLM technique is the need of transmission of Side Information bits to the receiver side for the recovery of the original data.

II. PARTIAL TRANSMIT SEQUENCE TECHNIQUE

Partial transmit sequences (PTS) is one of the most important methods that is used to reduce PAPR in the OFDM system [4]. PTS is performed in two main steps. That is the original OFDM signal is divided into a number of sub-blocks as the first step and then, the phase rotated sub blocks are added to develop a number of candidate signals. And from these signals the one with smallest PAPR is selected for

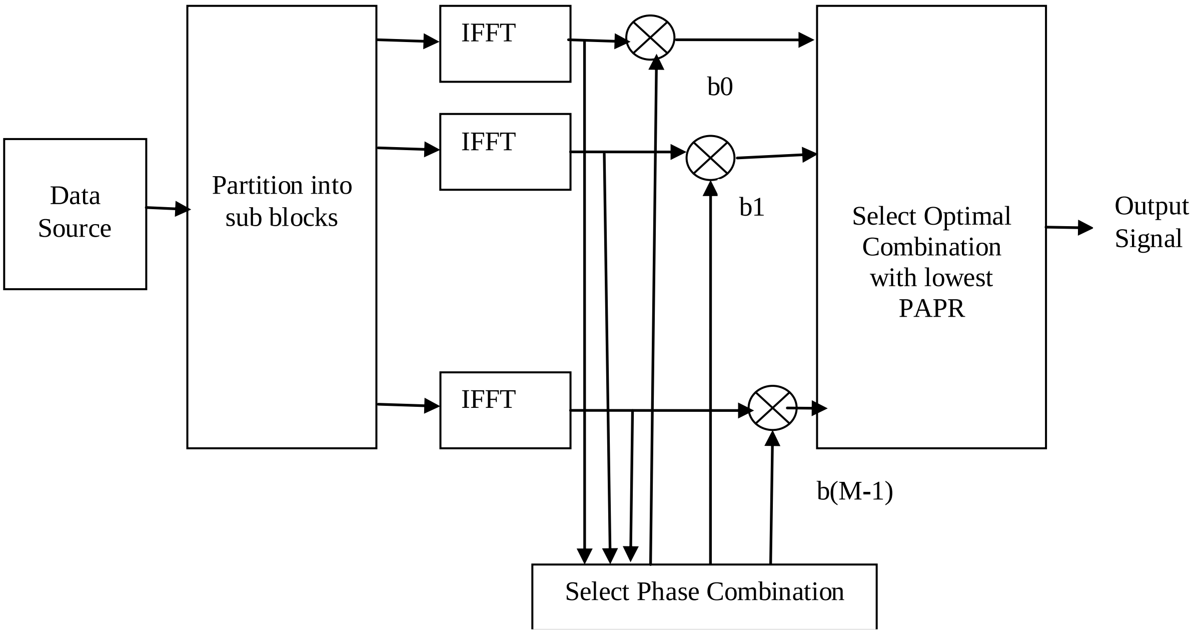

Fig.1. Block Diagram of PTS OFDM System

transmission. In Partial Transmit Sequence approach the input data block X is partitioned into M disjoint sub blocks these sub blocks are then transformed into M time domain partial transmit sequences. The generated partial sequences are independently rotated by phase factors. Then the M sub-block are optimally combined to obtain the time domain OFDM signals with the lowest PAPR [11].

In PTS algorithm the incoming bit stream is converted to a parallel block of data, as required in normal OFDM transmission. The parallel block of data is then divided into smaller sub-blocks. Each of these sub-blocks are of the same length as the original parallel block of data. As for example if there are N sub-carriers, then obviously the length of the parallel block of data will be N. And the length of each sub-block will also be N. However not all the N elements of a sub-block will be non-zero. And the division will be such that, some of the sub-carriers have non-zero values in a sub-block while others have zero. And it is to be noted that a set of sub-carriers cannot have non-zero values in more than one sub-block. In this way, effectively the addition of all sub-blocks will give the original parallel block of data as the sum. The sub-blocks are then simultaneously passed through IFFT blocks which perform the inverse Fourier transform of each of these sub-blocks. The output of each of these IFFT blocks is referred to as partial transmit sequence. Each of the PTSs is then simultaneously rotated by a certain pre-defined phase factor. The phase factor is selected from a set of allowed values which is defined earlier. Once rotation is complete, the phase-rotated PTSs are added up to get a candidate signal. The entire process is then again performed but with a different rs being multiplied with the PTSs. This process is continued until all possible combinations of phase-factor and PTS has been generated. Thus a large number of candidate signals are generated. The candidate signals are compared on the basis of their PAPR value and the one with the lowest PAPR is chosen as the correct OFDM symbol to be transmitted. PTS is a distortion less technique. That is the technique introduces no distortion in the signal during the processing. Hence the BER performance of the OFDM system is not affected.

PTS works with arbitrary number of sub-carriers. As the technique is not dependent on the number of sub-carriers and the complexity of the technique is not significantly affected by the number of sub-carriers any number of sub carriers can be used. Higher number of sub-carriers promises better data rates. So the technique provides the flexibility to work with any number of sub-carriers as per requirement. Works with any modulation: The technique imposes no restriction on the type of modulation required. It will work equally well with BPSK or QPSK or any higher order modulation.

III. EFFICIENT USE OF PTS

In this work we have proposed two methods which efficiently use PTS, PTS with segmentation and PTS with interleaving. Figure 2 shows the block diagram for the efficient use of Partial Transmit Sequence Technique. Both the methods divide the input block into two and apply PTS separately. Segmentation and interleaving [7, 8] are used to divide the input block of data. In PTS with segmentation the

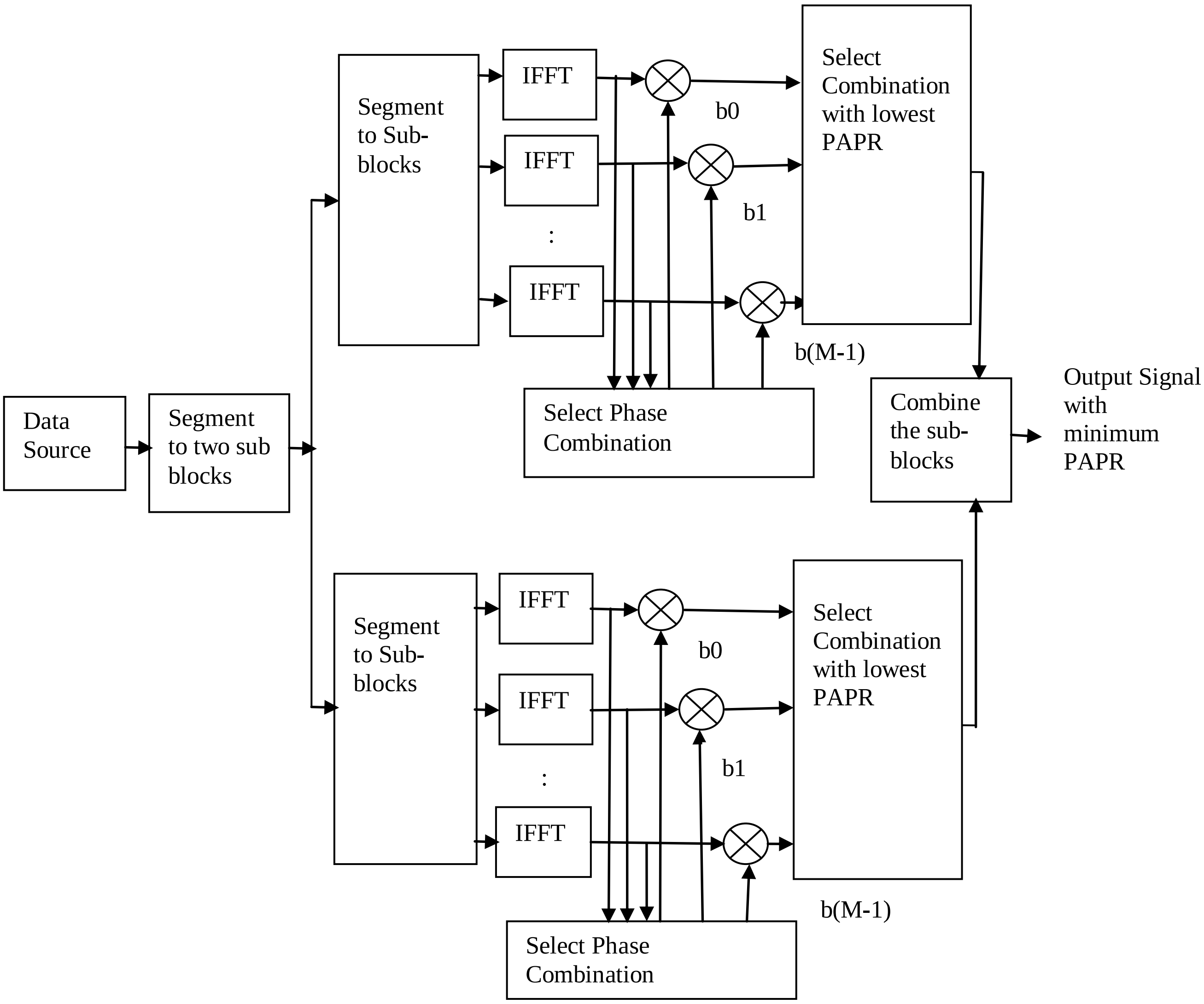

Fig. 2 Efficient Use of Partial Transmit Sequence Technique

input block is divided into first half and second half and then the technique is applied. Finally two sub blocks are combined together for the output signal. And in PTS with interleaving the input block is divided as even indexed data and odd indexed data. Here also PTS is applied separately to both the blocks.

IV. RESULTS

The results are simulated in MATLAB. And to represent the PAPR reduction performance Complimentary Cumulative Distribution Function (CCDF) of PAPR is used [10]. Figure 3 shows the CCDF plot of PAPR for the original OFDM signal and for the signal after PTS. The x-axis of CCDF plot of PAPR represents the threshold values and the y-axis shows the probability that the PAPR is greater than that threshold. The PAPR of the OFDM signal is very high. The simulation result shows that there is probability of occurance of signal with 9.5dB PAPR in original OFDM signal. And Partial Transmit Sequence technique is efficient in PAPR reduction.

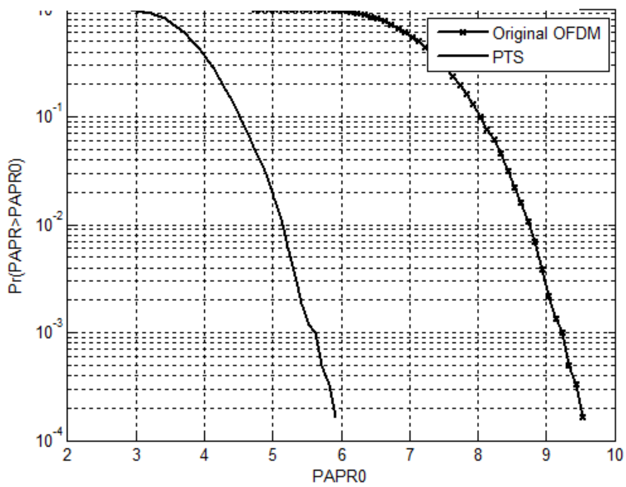

Fig 3. CCDF plots of PAPR for the original OFDM signal and for the signal with PTS

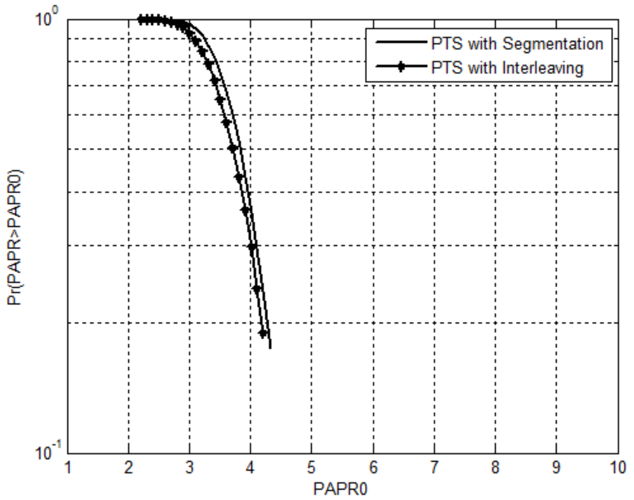

Fig. 4 CCDF plots of PAPR for PTS with interleaving and PTS with segmentation

The proposed techniques resulted in further PAPR reduction than the conventional PTS technique. The PTS with interleaving is more efficient than PTS with segmentation.

V. CONCLUSION

OFDM is a promising technology in wireless communication. And high PAPR is the major challenging issue in OFDM systems. Partial Transmit Sequence technique is an efficient method to limit high PAPR. In this paper we have proposed two methods to efficiently use PTS. And the techniques resulted in further reduction in PAPR than the conventional PTS. The PTS with interleaving has better PAPR reduction than PTS with segmentation.

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