PAPR REDUCTION IN OFDM

RITU MOR[1], RAMANJEET KAUR[2]

[1,2]Electronics and Communication Engineering, Kurukshetra University

---***---

ABSTRACT - *This paper presents a new partial transmit sequence (PTS) technique. It is used to effectively reduce the peak-to-average power ratio (PAPR) in orthogonal frequency division multiplexing (OFDM) technology and is implemented to solve the PAPR problem in orthogonal frequency division multiplexing .To achieve better PAPR performance the number of sub-blocks should be increased which is the sub-blocks using phase rotation factors to minimize PAPR over all transmit antennas and receive antennas. Partial Transmit Sequence (PTS) is an attractive scheme for PAPR reduction without distortion, but to obtain preferable PAPR performance it needs many Inverse Fast Fourier Transforms (IFFTs) which results in high complexity. This paper contains the simulation result of the proposed technique.*

KEY WORDS: **4G, OFDM, PAPR, PTS, IFFT.**

1. INTRODUCTION

With the advance of communications technology comes the demand for higher data rate services such as multimedia, voice, and data over both wired and wireless links. New modulation schemes are required to transfer the large amounts of data which existing 3rd generation schemes such as Global System Mobile (GSM), its enhanced version Enhanced Data Rates for Global Evolution (EDGE), and Wideband Code Division Multiple Access (WCDMA) cannot support. These new modulation schemes must be able to act over point to point links and in broadcast mode, support bi-directional communications, and be able to adapt to different requirements of individual services in terms of their data rate, allowable Bit Error Rate (BER), and maximum delay.

One new modulation scheme which has received significant attention over the last few years is a form of multicarrier modulation called Orthogonal Frequency Division Multiplexing (OFDM).

Despite the many advantages of OFDM it still suffers from some limitations such as sensitivity to carrier frequency offset and a large Peak to Average Power Ratio (PAPR). The large PAPR is due to the superposition of N independent equally spaced subcarriers at the output of the Inverse Fast Fourier Transform (IFFT) in the transmitter. A large PAPR is a problem as it requires increased complexity in the word length at the output of the IFFT and the Digital to Analog Converter (DAC).In this proposed thesis a single IFFT block is implanted in to PTS technique for reduction of PAPR in OFDM. The scheme is very efficient and avoids the use of any extra IFFTs as was done in PAPR reduction by ordinary PTS technique.

2. PEAK TO AVERAGE POWER RATIO

The PAPR is the relation between the maximum powers of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol.

$$PAPR_{(x_t)} \triangleq \frac{\max_{0 \le t \le NT} |x(t)|^2}{\frac{1}{NT}\int_0^{NT} |X(t)|^2 \, dt}$$

Distribution of PAPR in OFDM system

Complementary cumulative distribution function (CCDF)

- CCDF cures provides critical information about the signals in the 4G system
- Evaluate the performance of any PAPR reduction scheme
- Can be used to calculate BER

3. SINGLE IFFT BLOCK PTS TECHNIQUE

This technique is modified to incorporate only one IFFT block in place of multiple blocks and replace the parallel processing with serial processing. Figure-1 illustrates the Single IFFT block PTS.

The design approach has been concentrated on two major factors:

1. Reducing the number of IFFT blocks
2. Reducing the number of candidate signals.

The technique does not need a predefined threshold value to reduce the number of candidate signals. Hence the dependency of the performance of the technique on the choice of the threshold is removed. Mathematical complicacy has been avoided by keeping the mathematical principle same. The reduction in the number of IFFT blocks is from M to 1, unlike a reduction by half. This reduces the complexity even further. The optimization of the phase factor has been done in the same way as original PTS does. Added complexity due to extra logic and computation is avoided. Also the basic principle of PTS is maintained; hence the PAPR reduction performance is not degraded.

Let the incoming serial stream of data be represented as X. If the number of sub-carriers be N, then let the parallel block of data obtained after serial to parallel conversion be represented as:

$$X=[X_0, X_1, \dots \dots, X_{N-1}]$$

If the number of sub-blocks be M, the parallel data block **X** is divided such that at least $[N/M]$ elements in each sub-block will be non-zero. So the sub-blocks can be expressed as X_m where:

$$X=\sum_{m=0}^{M-1} X_m$$

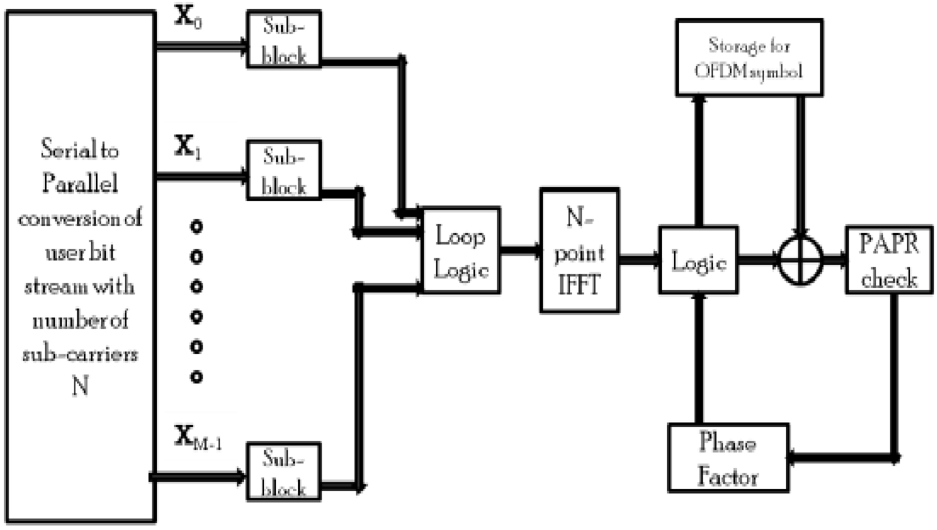

FIGURE 1: BLOCK DIAGRAM FOR SINGLE IFFT BLOCK PTS

Each of the sub-blocks is then passed through an N-point IFFT block to obtain the corresponding PTS given by:

$$x_m = IFFT\{X_m\} \qquad m=0,1,\dots\dots M-1$$

Let the number of allowed phase factors be W. So the phase factors can be expressed as:

$$b_w = e^{j\theta_w} \text{ ,w=0,1,......w-1}$$

The OFDM symbol formed after the $(m+2)^{th}$ iteration when m = [0, M-1] by choosing the optimum phase factor for each PTS can be hence expressed as:

$$\hat{x}_m = \min_{0\le w\le W-1}\left(\frac{\max_{0\le k\le N-1}\left|x_k b_w^{(m)} + \hat{x}_{m-1}\right|}{E[\left|x_k b_w^{(m)} + \hat{x}_{m-1}\right|]}\right)$$

4. SIMULATION AND DISCUSSION

The different values of the parameters considered are given below in Table 1.1:

Parameters Names	Value Used
Number of sub-blocks	128 and 256
Number of sub-carriers	8 and 16
Number of allowed phase factors	4 and 8

TABLE1.1: Values of parameters used for simulation

Different combinations of these parameters have been used to obtain the CCDF of the Single IFFT block PTS. It is expected that if the values of N, M and W are increased the performance will improve further. The results are illustrated through the following figures:

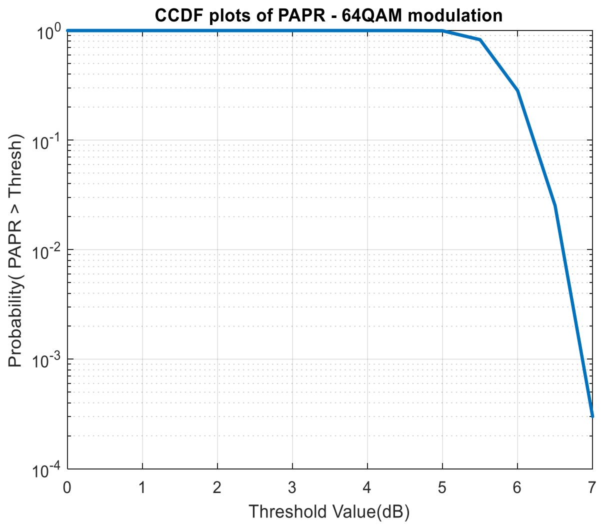

FIGURE 1-1: CCDF of PAPR WITH N=256, L=4 AND M=8 FOR OFDM WITH SINGLE IFFT BLOCK PTS TECHNIQUE

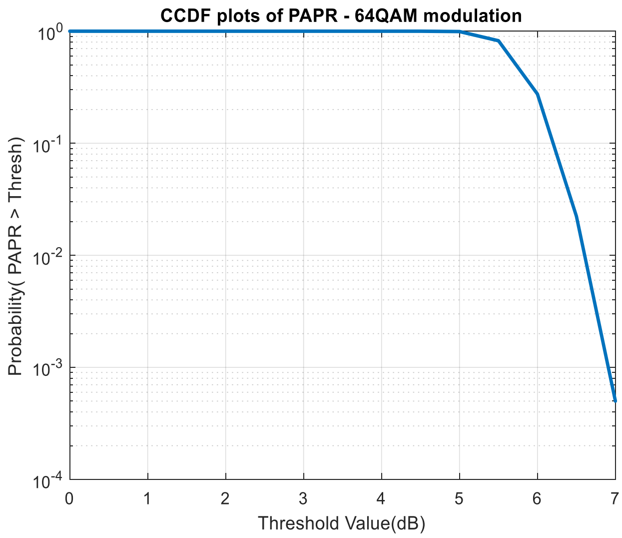

FIGURE 1.2: CCDF OF PAPR WITH N=256, L=8 AND M=16 FOR OFDM WITH SINGLE IFFT BLOCK PTS TECHNIQUE

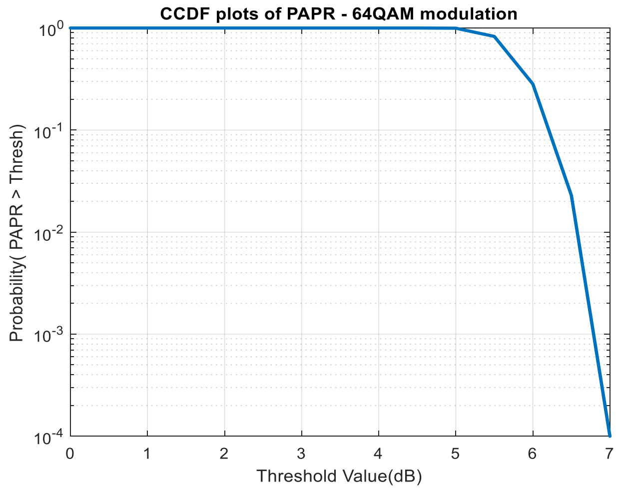

FIGURE 1.3: CCDF OF PAPR WITH N=128, L=4 AND M=16 FOR OFDM WITH SINGLE IFFT BLOCK PTS TECHNIQUE

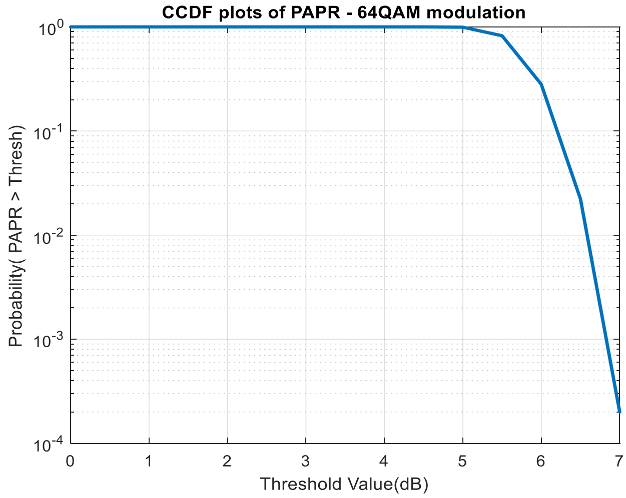

FIGURE 1.4: CCDF OF PAPR WITH N=128, L=8 AND M=8 FOR OFDM WITH SINGLE IFFT BLOCK PTS TECHNIQUE

This paper discussed a single IFFT block PTS technique which reduces the computational complexity of PTS by reducing number of IFFT blocks and by reducing numbers of candidate signals. PAPR reduction performance is improved by this technique. The choice of the phase factor has been done by simply checking with the preceding PTSs. This technique delivers performance significantly better than PTS technique. The hardware requirement has been reduced significantly by cutting down multiple IFFT blocks to one, only with the addition of smaller loop control logical blocks which do not contribute to complexity as much as the IFFT blocks. The performance has been effectively better as PAPR has been reduced in every step of formation of the OFDM symbol from the PTSs.

REFERENCES

[1].Shieh William, Djordjevic Ivan, "OFDM for Optical Communications," Elsevier, chap 2, pp 31-44, 20102.

[2].Lingyin Wang; Ju Liu, "PAPR Reduction of OFDM Signals by PTS With Grouping and Recursive Phase Weighting Methods", IEEE Trans. On Broadcasting, vol.57, no.2, pp-299-306, Jun 2011

[3].Jun Hou, JianhuaGe, Jing Li, "Peak-to-Average Power Ratio Reduction of OFDM Signals Using PTS Scheme With Low Computational Complexity", IEEE Transactions on Broadcasting, vol. 57, no. 1, pp- 143-148, March 2011

[4]. Sheng-Ju Ku, Chin-Liang Wang, Chiuan-Hsu Chen "A Reduced-Complexity PTS-Based PAPR Reduction Scheme for OFDM Systems", IEEE Transactions on Wireless Communications, vol. 9, no. 8, pp- 2455-2460, Aug 2010

[5].Haibo Li, Tao Jiang, Yang Zhou, “A Novel Subblock Linear Combination Scheme for Peak-to-Average Power Ratio Reduction in OFDM Systems”, IEEE Transactions on Broadcasting, vol. 58, no. 3, pp- 360-369, Sept 2012

BIOGRAPHY

Ritu Mor PG student, Dept. of ECE, Kurukshetra university, Kurukshetra. Received B.Tech degree from MDU , Rohtak , doing research work in 4G communications to receive M.Tech degree from KU, Kurukshetra, in Electronics and communication systems.