Peak to Average Power Ratio (Papr) Value Minimizing Techqniques for Helical Interleaved Orthogonal Fdm System

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***Abstract*— Orthogonal frequency-division multiplexing (OFDM) is a multi carrier, multi rate, multi symbol, frequency division multiplexing transmission system. In which a single very high data rate stream is divided in to a number of low data rate streams. High spectral efficiency due to orthogonal subcarriers is the major advantage of this system. The major disadvantage of this system is large Peak to Average Power Ratio (PAPR) due to multiplexing of signals. The high PAPR degrades the system performance. This paper presents different PAPR minimizing solutions for helical interleaved OFDM system. A current PAPR reduction technique reduces the PAPR to minimum of 12dB. Here we reduced PAPR to minimum of 8dB. The simulation for PAPR reduction has been done in MATLAB.**

Keywords- High-speed wireless, OFDM, peak- to- average power.

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a bandwidth efficient multiple carrier modulation technique, where the available spectrum is seperated into many number of subcarriers, with each subcarrier containing a less rate data stream [1]. OFDM has gained a vast interest in recent years because of its high robustness in the presence of serious multipath channel situations with very simple equalization, strangeness against Inter-symbol Interference (ISI), multipath channel fading with its high spectral efficiency. However, the PAPR [1] is a major disadvantage of multiple carrier transmission system such as Orthogonal FDM. Various techniques are available to reduce PAPR for OFDM system. In this paper, Selected Mapping (SLM) [4] and Partial Transfer Series (PTS) [3] are analyzed for the reduction of PAPR. Helical interleaving [5] is also proposed at the place of random interleaver for reduction of system complexity and memory requirement.

II. PAPR

Here is the introduction of PAPR in Mathematical equation form. PAPR is defined as the maximum power existing in the Orthogonal FDM transmission to the average power of the Orthogonal FDM transmission. Related Mathematical representation and formulae has been given below.

PAPR = Ppeak/Paverage

= max [|xn|2] / E [|xn|2]

Where, Ppeak = Highest Peak power of the Orthogonal FDM system.

Paverage = Average power of the Orthogonal FDM system.

$E[\cdot]$ is the expectation operator .

The PAPR of an oversampled parameter of $x(t)$ is calculated according to the above equation. In this equation our main goal is to minimize the max [|Xn|2].

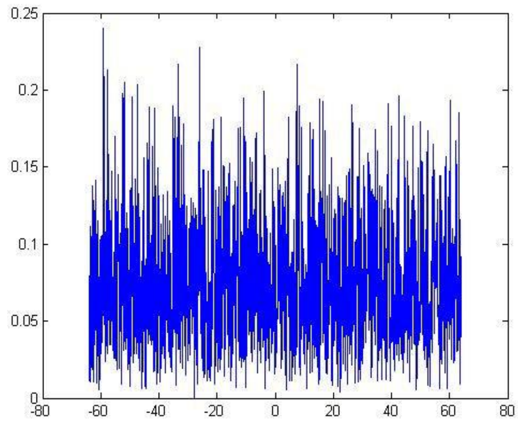

Figure 1: Orthogonal FDM System Signal consist sting sinusoidal maximum peaks

III. INTERLEAVER FOR OFDM SYSTEM

The Helical interleaver used in Orthogonl FDM System indicates the series order in which a modulator follows bits from an encoded data block [6]. The main design rule of helical interleavers is to start off from a pre-defined interleaver as a master interleaver, from which the family of helical interleavers are formed by following the interleaver indicators (indices) in a determined order. The generation process can be described as follows:

1) Generate a one-dimensional master interleaver of length Nc (e.g, a pseudo-random interleaver) and write the interleaver indices of the master interleaver row-wise into a matrix with Mr rows and Mc columns.

2) The 1st helical interleaver is formed from the master interleaver by observing the interleaver indicators column-wise from the matrix.

3) The remaining interleavers are generated by cyclically reading the interleaver indices from the diagonals of the

matrix. Different interleavers correspond to diagonals with different slopes; one can generate Mc helical interleavers from the master interleaver.

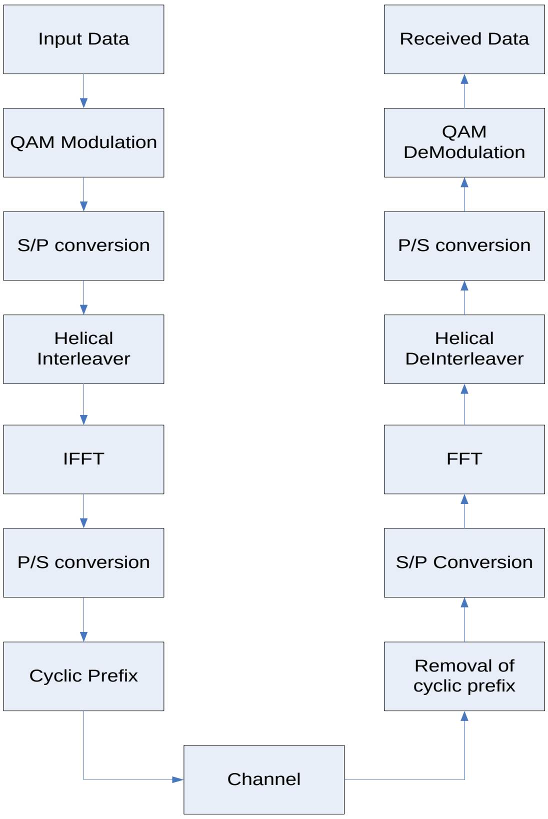

Figure 2: Block diagram Orthogonal FDM system with helical interleaver Technology.

Figure2 shows the simple block diagram OFDM system with helical interleaving scheme, useful for easy designing of system. This scheme also reduces complexity and the memory requirement of the OFDM System.

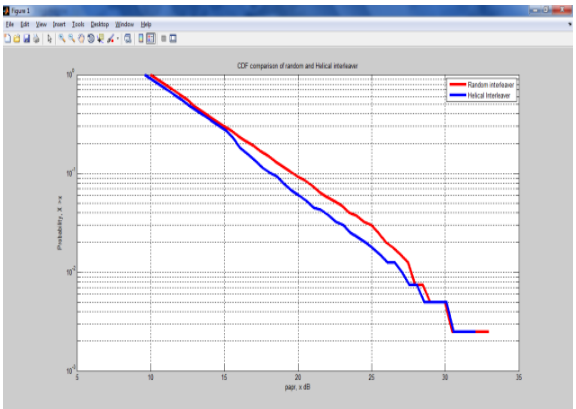

Figure 3: Comparison of Helical interleaver and random interleaver performance against PAPR.

Figure 3 shows the performance of randomly interleaved and helical interleaved OFDM.

IV. ALGORITHMS USED FOR REDUCTION OF PAPR

1. Selective mapping

The Cumulative Distributive Function (CDF) of the real signal sequence PAPR above threshold value of PAPR is written as, *Pr*{*PAPR* > *PAPR*0} Thus for K statistical independent signal waveforms, CCDF can be written as *[Pr*{*PAPR* > *PAPR*0}]R, so the probability of PAPR exceeds the same threshold [2]. Assuming that M-Orthogonal FDM symbolic functions carry the same messages and that they are constantly independent of one another [5]. In this situation, the probability of PAPR more than Z is equal to the multiplication result of each independent probability.

In selection mapping method, initially M constantly independent parameters which represent the same messages are formed, and next, the resulting M constantly not dependent on data blocks $Sm=[Sm0,Sm1,SmN-1]^T$ for m=1,2,...,M are then forwarded into IFFT operation simultaneously [7]. $Xm=[X_1,X_2,X_N]^T$ in discrete time-domain are accepted and then the PAPR of these M vectors are counted individually. The sequences xd with the very small PAPR is selected for ultimate serial sending [8]. Figure 4 shows the basic block diagram of selection mapping technique for suppressing the high PAPR.

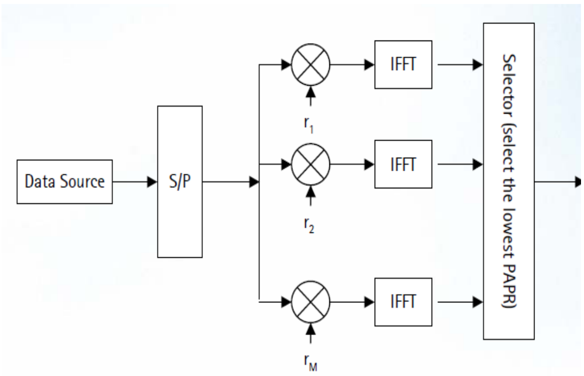

Figure 4: Block diagram of selective mapping algorithm in Orthogonal FDM .

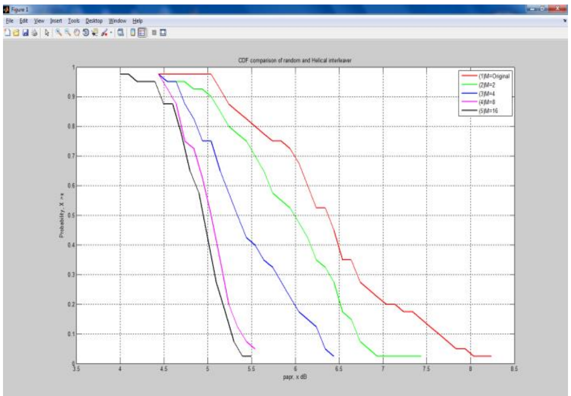

Figure 5: Comparison and differences indication of PAPR minimizing trails with different values of M for helical interleaved Orthogonal FDM

Figure 5 shows the CDF as a function of PAPR distribution when SLM method is used with 64 quantity of subcarrier. Figure 5 shows the same result for 128 quantity of subcarrier. M select the value of 1 (without using SLM method), 2, 4, 8 and 16. It is observe in Figure 5 that with increase of value M, PAPR's CDF gets smaller. It shows the minimizing of PAPR about 8dB.

2. Partial transmit sequence

Partial Transmit Sequence algorithm is a method for developing the statistics of a multicarrier signal. The fundamental solution of PTS algorithm is to divide the real Orthogonal FDM sequence into many number of sub-sequences and for each sub-sequences multiplied by different weighted values upto an optimum value is chosen.

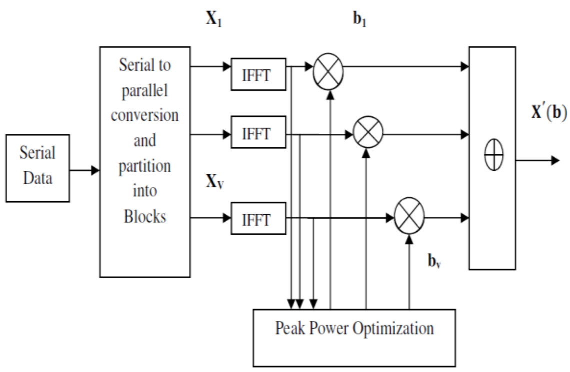

Figure 6: Block diagram of PTS

Figure 6 is the block diagram of PTS technique. From the top left corner diagram, the data message in frequency domain X is divided into V un overlapped many sub-blocks and each sub block vectors has the same size N [08]. So for each sub-block it consists N/V nonzero quantities and set the rest part to zero. Assume that these sub-blocks have the same size and no gap between each other. The sub-block vector is represented by $X=\sum b_v X_v$ where b_v is a weighting factor of the rotation of phase . The signal in 't' domain is obtained by applying IFFT operation on, that is $X=IFFT(x)= \sum b_v IFFT(x_v)= \sum b_v X_v$

For the optimum result one of the suitable factor from combination $b = [b_1, b_2,.., b_v]$ is selected [10].

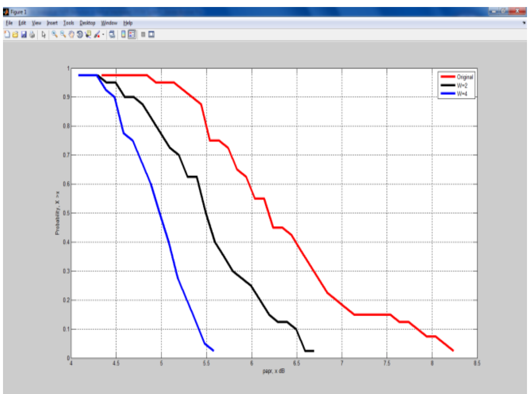

Figure 7: Comparison of PAPR reduction performances with variety values of W for helical interleaved OFDM.

Fig. 7 shows that there are varying parameters which impact the PAPR reduction performance these are: 1) The number of sub-blocks V, which influences the complexity strongly; 2) The number of possible phase value W, which impacts the complexity; and 3) The sub-block partition schemes. Here, only one parameter is considered that is sub-block size V. Figure 7 shows that PTS technique develops the performance of Orthogonal FDM system. It can be exposed that with increasing the value of 'V'. So that the PAPR performance becomes much better .

3.COMPARISION BETWEEN PTS AND SLM:

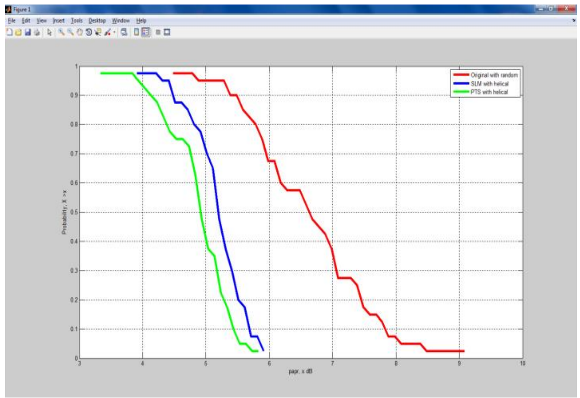

Figure 8: Comparison of PAPR minimizing performances between PTS and SLM techniques for helical interleaved Orthogonal FDM

In Figure 8, it is clear that PTS technique gives a good PAPR minimizing performance compared with SLM technique.

V. CONCLUSION

Orthogonal FDM is a very attractive technique for wireless form data communications due to its spectrum efficiency and data channel robust property. One of the main disadvantage of Orthogonal FDM systems is that the composite transmit signal can exhibit a very high PAPR when the input sequences are highly correlated. Here, Layer Specific Helical Interleaver system is used to minimize the memory requirement of the Orthogonal FDM System and several important aspects are described as well as mathematical related data analysis is provided, including the distribution of the PAPR used in Orthogonal FDM systems. Two techniques, SLM and PTS are used to reduce PAPR, which have the potential to provide substantial reduction in PAPR. PTS method performs better than SLM method in reducing PAPR in OFDM systems.

VI. REFERENCES

[1] Davis, J.A, Jedwab, J, "Peak-to-Mean power avoid and error correction for Orthogonal FDM transmission using Golay sequences and Reed-Muller codes," IEEE Electronic Letters, vol. 33, no. 4, Feb 1997, pp. 267-268.

[2] Y.Wu and W. Y. Zou, "Orthogonal frequency division multiplexing: A multi-carrier modulation techniques," IEEE Trans. Consumer Electronics, vol. 41, no. 3, pp. 392–399, Aug. 1995.

[3] Lei Xia, Xiao Yue, et al., "Analysis of the performance of partial transmit sequences with different sub-block partitions," IEEE International Conference on Communication, Circuits and Systems Proceedings, ICCCAS June 2006, vol. 2, pp. 857-858.
[4] Bauml, R.W, Fischer, R.F.H and Huber, J.B, "Reducing the peak-to-average power ratio of multicarrier modulation by selected mapping," IEEE Electronic Letters, vol. 32, no. 22, Oct 1996, pp. 2056-2057.
[5] Cooper, G.R, Nettleton, R.W, "A spread spectrum technique for high capacity mobile communications," IEEE Transaction on Vehicular Technology, Nov 1978, vol. 27.
[6] Bansal R, Anand S. Purwar D.& Aasheesh Shukla. "Application of Antenna Diversity in HIDMA scheme using gold codes"IEEE International conference on communication system and network technologies", pp. 228- 231, 201.
[7] Jayalath, A.D.S, Tellainbura, C, "Side Information in PAR Reduced PTS-OFDM Signals," Proceedings 14th IEEE Conference on Personal, Indoor and Mobile Radio Communications, Sept. 2003, vol.1.
[8] Christopher Gerald Santos, "Peak-to-Average power ratio reduction solutions for OFDM," Philippine Journal of ICT and Microelectronics, vol.1, no. 2, July 2002.
[9] Oh-Ju Kwon and Yeong-Ho Ha, "Multi-carrier PAP reduction method using sub-optimal PTS with threshold," IEEE Transactions on Broadcasting, June. 2003, vol. 49.