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PAPR Reduction in OFDM by using Companding Technique

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***Abstract*— Orthogonal frequency division multiplexing (OFDM) is a method performed in Long Term Evolution (LTE) systems to accommodate various users within a specified bandwidth .one of the advantage of the OFDM is that, it divides a channel into several narrow orthogonal bands and also makes them non interfering with each other. Drawback of the OFDM is PAPR. OFDM signals passes through high power amplifiers there will be some losses that occur which leads to decrease in the efficiency of the system. To overcome the problem of PAPR we have various methods, partial transmit sequence is one such method for reduction of PAPR. Cyclic Shifted Sequence (CSS) is a method which is an extension to the PTS method. in the CSS, shift value selection plays a major role in the proposed method along with the CSS scheme with shift value(SV) selection we add another block called as Companding as a result we get better results.**

Keywords*— Orthogonal Frequency Division Multiplexing (OFDM) System, Partial Transmit Sequence (PTS) Method, peak to average power ratio(PAPR)Problem, companding.

I. INTRODUCTION

Advanced communication technologies support high-speed Internet, high-quality multimedia and high definition streaming videos. Previously used systems such as TDMA, FDMA and CDMA are not efficient .To get all these requirements we implemented a system known as OFDM system. Chan has introduced the technology in the year 1966 and improved by Weinstein and Ebert in 1971.OFDM is an appealing method in advance communication system to achieve elevated information rates. Applications of OFDM are Audio Broadcasting ,DSL internet access ,wireless LAN, power line networks and 4G mobile communications,. There are some of the drawbacks of OFDM as, High PAPR :Due to overlapping of signals, peaks will be formed which causes distortion when they transmit through nonlinear High power Amplifiers. Frequency offset: the drawback of frequency offset is due to Doppler shift caused by the relative motion between the transmitter and receiver.

Due to this PAPR problem the cost will increase. To overcome of the PAPR problem there are various schemes proposed such as active constellation extension (ACE) [2], tone reservation (TR), partial transmit sequence (PTS) [3],and selected mapping(SLM) [4]. In the PTS Scheme, the input symbol sequence is given to the serial-to-parallel converter as a result this converts data from serial to parallel and this data is split by the amount of sub sequences of the disjoint input symbol, then inverse fast Fourier transform is applied to each input symbol subsequence and to this result we apply a set of rotational factors and the PAPR is computed for each sequence and then the minimum PAPR *sequence is* selected and transmitted. CSS scheme is an extension of the PTS scheme, in this scheme cyclic shift takes place instead of the set of rotational factors. CSS scheme provides better results than that of the PTS scheme. Selection of the shift value (SV) sets plays a major role. we obtain many SV sets, among these SV sets we have to select some SV sets [1]. There are many techniques for the reduction of the peak value. In this proposed method companding is used.

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II. INFORMATION

A. OFDM systen and PAPR Problem

OFDM system consists of IFFT block and conversion of the frequency domain occurs to the time domain as

$$y(n) = \frac{1}{\sqrt{M}} \sum_{k=0}^{M-1} Y(k) e^{\frac{j2\pi km}{M}} \quad (1)$$

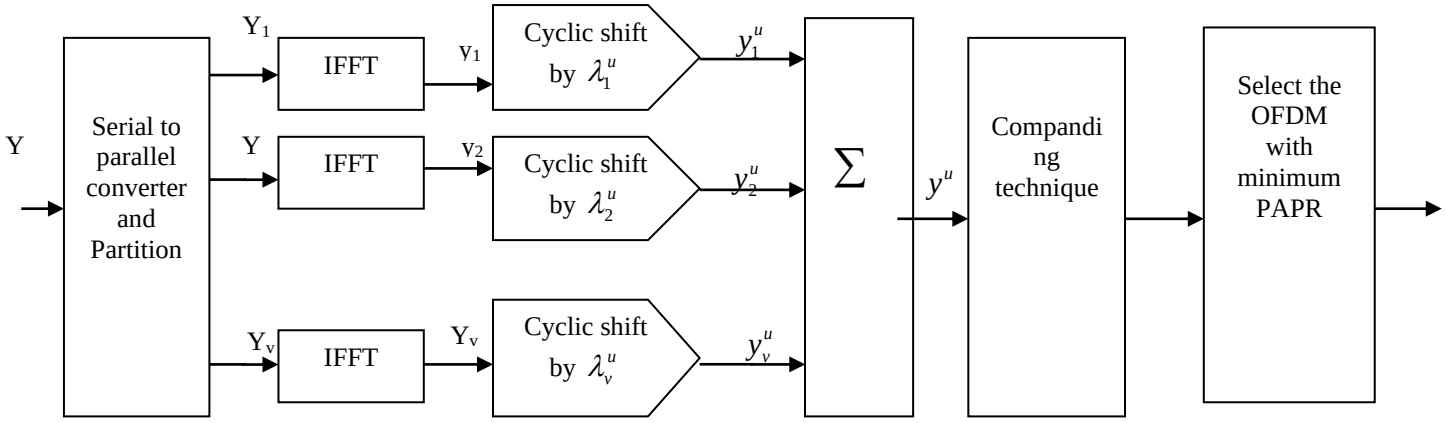

Fig. 1. Proposed block diagram

Where, M is the subcarrier set.

The OFDM system's PAPR as

$$PAPR = \frac{\max_{0\le m\le M} |y(\mathrm{m})|^2}{E\left[|y(\mathrm{m})|^2\right]} \qquad (2)$$

Where, E [.] reflects the operator of expectations.

B. Cyclic shifted sequences

In the CSS scheme, the inputs are given to serial-t- parallel convertor then the data is converted from serial information to parallel information and this parallel information is partitioned into the V sub blocks Y_1, Y_2, …., Y_V. Then it is given as input to the IFFT block which converts time domain as y_1, y_2, . . , y_v .These subsequences are moved cyclically and coupled to create an alternative U-th signal sequence as

$$y^u = \sum_{v=1}^{V} y_v^u \qquad (3)$$

Where, some factor y_v^u represents the cyclically shifted version of the left. In case of previous methods like SLM and PTS schemes, the lowest PAPR is chosen by passing some extra bits are transmitted along with the information at the transmitter section as result at the receiver section use some additional techniques. in order to retrieve information the CSS system employs three techniques of partitioning, i.e. r andom, adjacent and interleaved techniques of partitioning. Among these methods random partition method provides better results.

III. IN THE CSS SCHEME SHIFT VALUE SELECTION

CSS scheme, PAPR reduction performance is mainly dependant on how we choose U SV sets. In general there will be M^V possible cases among these M^V cases it is very difficult to select U SV sets.

A. ACF of OFDM System

Let T_v be the V-Th OFDM signal sequence x_v power spectrum

$$T_v = \{q(0), q(1), \ldots\ldots q(M-1)\} \qquad (4)$$

Where, q (k) = E {| Y_v (k) |^2}the values of p(k) will be zero or one. ACF R_{y_v} is given as IDFT of S_v .

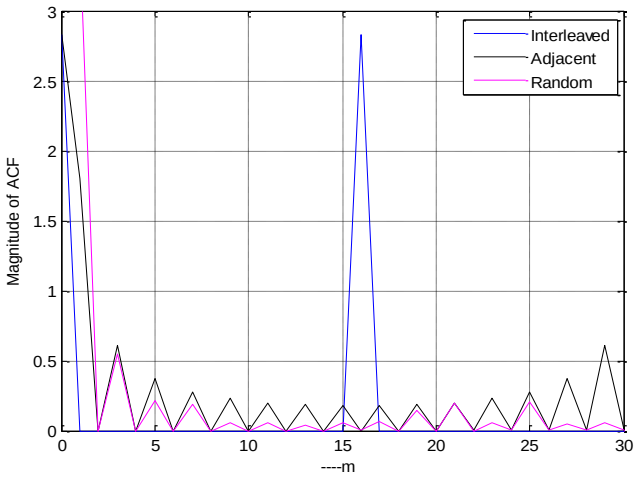

Fig.2. Magnitude of autocorrelation of different partition cases when M=32, V=2.

IV. PROPOSED COMPANDING SCHEME

A. linear companding

A new companding transform is formed and the main function of this scheme is to remove the part above the

maximum amplitude part that is B_c. Also the range in between the maximum value and B_i is linearly transformed. The companding function is mathematically written as

$$Z(x)=\begin{cases} x & |x|\le B_i \\ kx+(1-k)\,B_c & B_i\le|x|\le B_c \\ \mathrm{sgn}(x)B_c & |x|>B_c \end{cases} \quad (5)$$

B. A-law companding

A-law is CCITT recommended and is used in Europe and it is mathematically defined as

$$F(x)=\begin{cases} \mathrm{sgn}(x)\ \dfrac{A|x|}{(1+\ln A)} & 0\le|x|\le\dfrac{1}{A} \\ \mathrm{sgn}(x)\ \dfrac{(1+\ln A|x|)}{(1+\ln A)} & \dfrac{1}{A}\le|x|\le 1 \end{cases} \quad (6)$$

Where, A is the compression parameter. However the dynamic range of A-law companding is higher than the μ -law companding.

V. SIMULATION RESULTS

In OFDM system generally QAM or QPSK modulation techniques are used. But in this paper 16-QAM is used for all results. M input sequences are partitioned into V=4 by using certain partition method i.e we used random partition method . All the simulations are done using MATLAB.

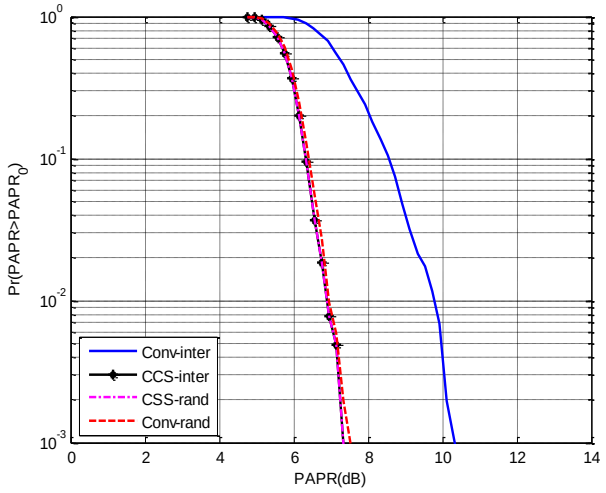

Fig.3.Comparing the PAPR of CSS and conventional PTS schemes when M=64

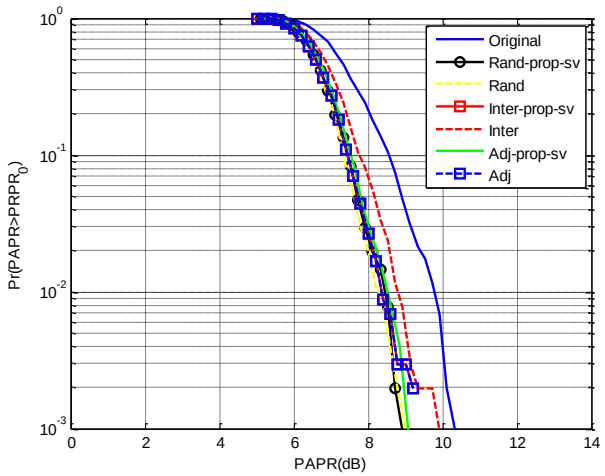

Fig.4.Comparing the PAPR of reduction performances of CSS scheme and CSS scheme with SV sets when M=64

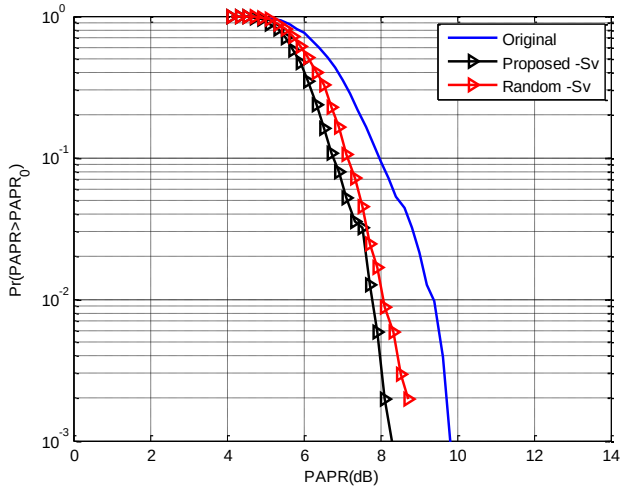

Fig.5.Comparing the PAPR of original OFDM, arbitrary generated SV sets and proposed SV sets when M=32

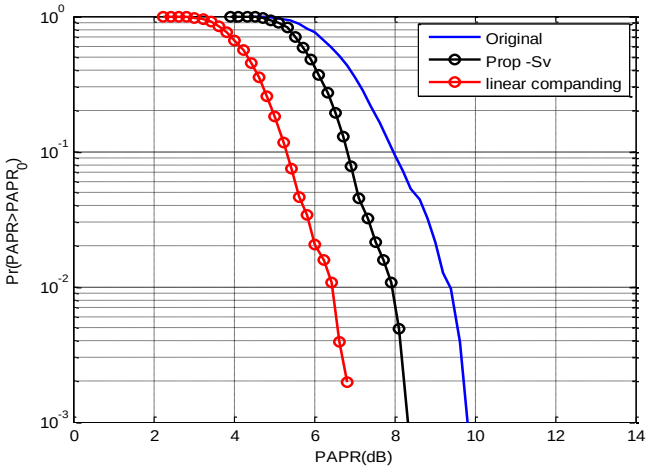

Fig.6. Comparing the PAPR of original OFDM, proposed SV sets and linear Companding technique when M=32

TABLE. 1. COMPARING THE PAPR OF ORIGINAL OFDM, PROPOSED SV SETS AND COMPANDING TECHNIQUE WHEN M=32

PAPR(dB)	Methods(CCDF)		
	Original	CSS with proposed SV sets	CSS with linear companding
3.92	0.999	0.992	0.403
5.21	0.957	0.818	0.116
5.6	0.87	0.58	0.034
6.6	0.51	0.192	0.010
7.2	0.28	0.03	0.0019

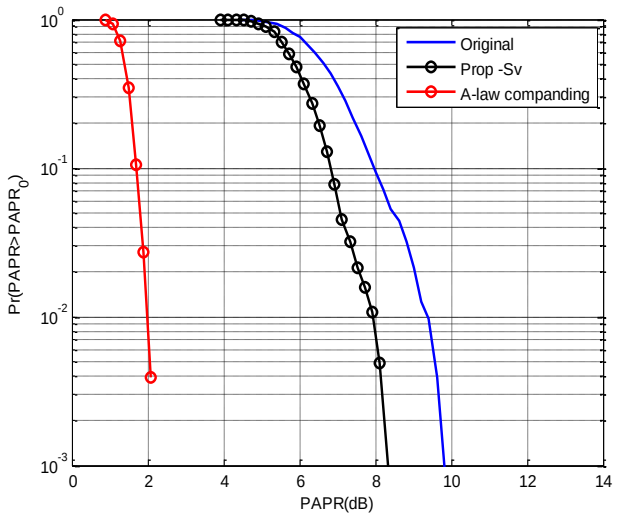

Fig.7. Comparing the PAPR of original OFDM, proposed SV sets and A-law Companding technique when M=32

VI. CONCLUSION

To overcome the problem of PAPR we have various methods, partial transmit sequence is one such method used for reduction of PAPR. Cyclic shifted sequence (CSS) is a method which is an extension to the PTS method. In the CSS, shift value selection plays a major role in the proposed method along with the CSS scheme with shift value (SV) selection, we add another block called as Companding in this companding block we go for different methods that include linear companding and A-law companding. It is noted from the simulation outcomes that the companding of A-law will yield better outcomes.

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