

# Implement PAPR Reduction in OFDM System Using Reduced Complexity PTS with Companding

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**Abstract:** A non-constant envelope with high peaks is a main disadvantage of Orthogonal Frequency Division Multiplexing (OFDM). These high peaks produce signal excursions into non-linear region of operation of the Power Amplifier (PA) at the transmitter, thereby leading to non-linear distortions and spectral spreading. The probabilistic method scrambles the signal by computing with phase factors. Partial Transmit Sequence (PTS) is one of the techniques which reduces PAPR. The computational complexity of PTS can be reduced by using cost function  $Q_s$  for each OFDM symbol. The symbols with  $Q_n \geq$  threshold are considered as the signal with lowest PAPR. To promote the lowest PAPR a  $\mu$ -law and A-law companding is used without amplifying the complexity.

**Keywords-** OFDM, PAPR, PA, PAPR; DCT;

## I. INTRODUCTION

Globally, Multimedia plays a foremost role in this clever and international with its creation of 4th technology wireless conversation with high demand but while the spectrum for verbal exchange stays very less than the quantity of users. In Single provider system, the single service engages the whole conversation bandwidth while in multi-carrier the to be had communication bandwidths are divided by way of many subcarriers. Due to this, every subcarrier receives smaller bandwidth than the bandwidth of single server system. To conquer this, OFDM may be used which comes up with satisfactory bandwidth performance, high-pace information costs & its proof against frequency selective fading marks. The base of all 4G verbal exchange is OFDM because of its excessive-speed information rate as excessive as 100Mbps, the sizable potential of some of the subcarriers & giant coverage with excessive mobility. OFDM are broadly & majorly utilized in DAB, DVB & LTE & a great deal extra.

In OFDM, tight frequency synchronization, time offset, peak to average power ratio (PAPR) and channel estimation are the predominant negative aspects. The impartial phases of subcarriers lead to optimistic impact when all subcarriers have the equal phase which ends up in high height amplitude resulting in a signal with high PAPR charge. So, the amplifier Q factor operates in saturation region which leads to nonlinear amplification due to the more amplitude of OFDM signal than the linear range of transmitter amplifier. In those dynamic range amplifiers, the efficiency lacks by reducing the Battery Life & Carbon Footprint. Mitigation of such optimistic & unfavorable results are important for stepped forward machine overall performance [1].

The boom in no. of sub-companies also will increase the PAPR of OFDM which degrades the system performance of power amplifier & its efficiency. To triumph over the hassle of High PAPR few PAPR reduction strategies are used known as Distortion & distortion fewer strategies. The distortion the method includes clipping, filtering, peak windowing, and companding, wherein the data are distorted by means of several strategies without affecting the data cost of the signal & with none upward thrust in power of the signal. The Distortion much less the technique includes Selected Mapping (SLM), Partial Transmit Sequence (PTS), coding techniques, interleaving and tone reservation and injection technique in which the data undergoes scrambling technique without any distortion in data [2,3].

## II. RELATED WORK

DCT precoded SLM technique for PAPR reduction in OFDM systems was done by I. Baig et al., (2010). MIMO OFDM Wireless Communication with MATLAB was done by et al., Y. Cho (2010). Combined DCT and companding for PAPR reduction in OFDM signals was done by Wang (2011). A PAPR reduction

scheme without side information for OFDM signal transmissions was done by Takeda and Adachi (2012). Low complexity PAPR reduction technique for OFDM systems using modified widely linear SLM scheme was done by L. Yang et al., (2012). Precoded DCT and low complexity SLM for PAPR reduction in OFDM systems was done by Nugroho and Kim (2013). PAPR reduction scheme with selective tone reservation for OFDM signals was done by C.-C. Chen et al., (2013). Linear precoding schemes for PAPR reduction in mobile WiMAX OFDMA System was done by Jijina and Pillai (2014). A Review on PAPR Reduction Techniques was done by yogita et al., (2014)

This method employs a clipper that limits the signal envelope to a predetermined clipping level (CL) if the signal exceeds that level; otherwise, the clipper passes the signal. The out-of-band distortion causes spectral spreading and can be eliminated by filtering the signal after clipping but the in-band distortion can degrade the BER performance and cannot be reduced by filtering. However, oversampling by taking longer IFFT can reduce the in-band distortion effect as portion of the noise is reshaped outside of the signal band that can be removed later by filtering. In this scheme a predetermined threshold level is defined and if the high peak goes beyond this predetermined threshold, it is multiplied by a weighting function known as window function. The most commonly used window functions include Cosine, Hamming, Hanning, Kaiser and Gaussian.

Windows. author described a scheme to perform windowing on a clipped and filtered signal repeatedly for PAPR reduction and achieved 7dB PAPR reduction at CCDF value of  $10^{-3}$ , within 1 dB increase of  $E_b/N_0$  at  $10^{-4}$  BER. An advanced peak windowing method is discussed where new weighting coefficients are introduced whenever successive peaks are generated within a half of the window length. The successive peaks can be restrained to a given threshold level after applying the new weighting coefficients. author introduced sequential asymmetric superposition (SAS) which is a two new peak windowing methods and optimally weighted windowing (OWW) to deal with closely spaced peaks to avoid high PAPR values.

### III. METHOD OF SOLUTION

This method basically applied for audio signals. Companding consist compression and expansion. After companding, the lower peak values are increased but higher peaks remain constant and hence, average power of OFDM signal is increased. Hence the peak to average power ratio decreases. Companding transform can be generally classified into four classes: linear symmetrical transform (LST), linear asymmetrical transform (LAST), nonlinear symmetrical transform (NLST), nonlinear asymmetrical transform (NLAST). Many companding transforms which belongs to the above four mentioned classes, are discussed in the literature.  $\mu$ -law companding transform is used to reduce PAPR. The examined the effect of companding on the BER performance of the OFDM system in the presence of AWGN and concluded that a reasonable symbol error rate is achieved by properly choosing companding coefficients. A NLAST to reduce PAPR is proposed in reference using the error function transformation given by  $x_c[n] = k_1 \operatorname{erf}(k_2 x[n])$ , where  $k_1$  and  $k_2$  are properly chosen coefficients based on statistics of the transmitted OFDM signal. If  $k_1$  and  $k_2$  are chosen properly, then it projects the high peaks of the signal envelope into the nonlinear region of the companding function, while the lower magnitudes are projected onto the linear region. This enhanced the low values, while high peaks are relatively attenuated.

**Partial Transmit Sequence (PTS):** In PTS, an input data block of length  $N$  is partitioned into a number of disjoint sub-blocks. Then each of these sub-blocks are padded with zeros and weighted by a phase factor. The schematic is shown in Figure 1.

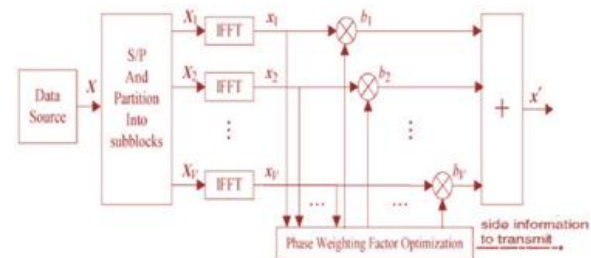


Fig.1 Block diagram of PTS

decreases the peak power, and, consequently, reduces PAPR. a similar NLAST which uses the error function is proposed to transform the Rayleigh

distributed envelope or the exponentially distributed power of the original OFDM signal into uniform distribution. This method either generates multiple permutations of the OFDM signal and transmits the one with minimum PAPR or to modify the OFDM signal by introducing phase shifts, adding peak reduction carrier or changing constellation points. Major techniques under this category are as follows:

The basic idea in SLM technique is to generate a set of sufficiently different candidate data blocks by the transmitter where all the data blocks represent the same information as the original data block and select the favorable having the least PAPR for transmission. Side information [SI] about the phase factor is needed to be transmitted separately to decode the OFDM symbol at the receiver side. For M phase sequences  $[\log_2 M]$ , side information requires a lot of computations to choose the best candidate for large block sizes. To solve this complex problem, a lot of work has been done in this field. A method to reduce computational complexity is proposed in [19] where an intermediate k-stage IFFT block is used to partially IFFT the block and then phase sequences are multiplied to it, remaining n-k stage IFFT is done after it. The computational complexity reduction ratio (CCR) is tabulated for various values of n-k, M and N.

For lower value of n-k up to 72% CCR is achieved. A scheme is proposed to generate a candidate signal by combining OFDM signals and its cyclically delayed version of varying delay and phase, same PAPR performance is achieved at reduced complexity of 50% to 76%. In [20], additive sequences are used for generation of new candidates from the existing one, scheme achieves a CCR up to 88% for the multiplication and 78% for addition at  $M=40$ . Intermediate IFFT stages are used, however in place of multiplying phase rotation, the proposed scheme generates OFDM candidates by cyclically shifting the connections at the intermediate IFFT stages, achieved CCR for multiplication and addition is 70% for 1024 subcarriers and  $M=8$ .

In this method the reduced complexity is combined with linear companding techniques as follows:

- As shown in Fig. 3 the data signal is divided into V disjoint subblocks.

find  $x_v = IFFT\{X_v\}$   
compute  $Q = \{Q_0, Q_1, \dots, Q_{N-1}\}^T$

$$Q_s = \sum_{v=1}^{V-1} |x_{v,s}|^2 \text{ for } 0 \leq s \leq N-1$$

tabulate  $Q_s \geq \frac{\sigma_s}{v}$  as a set (T)

- signals of the samples  $s \in T$  are used to compute optimum signal for PAPR.
- the computed optimum signal of samples  $s \in T$  is again computed by A-law or  $\mu$ -law companders
- The companded OFDM signal PAPR is calculated.

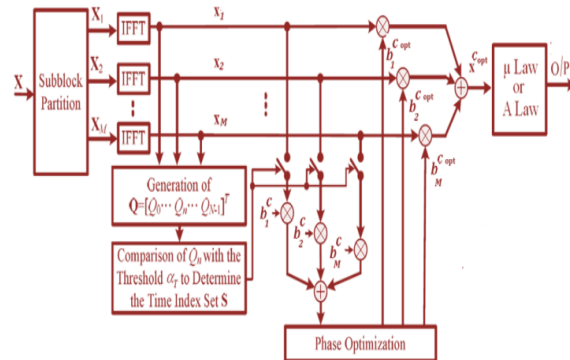


Fig. 2 Reduced complexity OFDM system with companding

#### IV. CONCLUSION

In reduced complexity PTS OFDM system [8], the PAPR is reduced compared with conventional PTS. Using this method, the computational complexity is reduced based on the cost function by summing the samples of the time symbols 's' in V disjoint subblocks. As the  $\gamma$  decreases, the PAPR decreases. The reduced complexity PTS with companding OFDM system further increases the efficiency of high power amplifiers by reducing the PAPR to lower values.

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