

Review Paper on PAPR Reduction Techniques in OFDM System

Sukhraj kaur* and Gurpreet Singh Saini

Lovely Professional University, Jalandhar - 144411, Punjab, India;
sukhrajkaus911@gmail.com, gurpreet.16889@lpu.co.in

Abstract

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier transmission scheme. This is used in the fourth generation wireless communication. The main advantage of OFDM, cross talk between the sub channels is eliminated and inter carrier bands are not required. Coin have two sides similarly OFDM have a some advantages and disadvantages, according to this quotation there have a major drawback arises in the OFDM is known as a PAPR (Peak to average power ratio). PAPR reduction techniques, based on computational complexity, bandwidth expansion, spectral spillage and performance. PAPR problem is reduced by the techniques which improves the signaling same as the OFDM. It improve the BER (Bit error rate) through these techniques.

Keywords: Clipping and Filtering, CCDF (Complementary Cumulative Distribution Functions) Peak Windowing Multicarrier Modulation, HPA (High Power filter), PTS, SLM (Selective Mapping Technique)

1. Introduction

Orthogonal frequency division multiplexing (OFDM) is a one of the multicarrier modulation (MCM) technique which is very useful in the mobile communication for the data transmission. It can increase the bit error rate (BER). OFDM (Orthogonal frequency division multiplexing) has many advantages like robustness in the frequency selective fading channels. It is against the ISI and fading, which causes by multipath propagation, the major drawback in the OFDM (Orthogonal frequency division multiplexing) signal HPA (High power filter) which producing the non-linearity in the system clipping which degraded the bit error rate (BER). peak windowing is also another latest technique which is used in the OFDM it is simply reduced the high peak amplitude of the signal and explain the part of distortion to the spectrum of the signal

2. PAPR in OFDM Signal

These are high peaks which limit the system performance are necessary to remove. Let data block of length N be represented by vector

$X_k = [X_0, X_1, X_2, \dots, X_{N-1}]$ over time interval $[0, T]$, OFDM symbol can be written as

$$X(S) = \sum_{k=0}^{N-1} x(k) e^{j2\pi k f_0 t} \quad (1)$$

Mathematically defined as

PAPR

$$\text{PAPR}_{\text{db}} = 10 \log(\max(x(t)x^*(t))/E(x(t)x^*(t)))$$

Where $x(t)$ is the original signal $x^*(t)$ is the signal power

$$E(x(t)x^*(t)) \text{ is the average signal power} \quad (2)$$

3. Literature Review

1. A Novel Multi-Points Square Mapping Combined With PTS to Reduce PAPR of OFDM Signals Without Side Information : Yang Zhou and Tao Jiang (2009) :-

In this paper, we propose a novel multi-focuses square mapping (MSM) plan. At that point, portray in subtle element how to consolidate the proposed MSM plan with routine halfway transmit arrangement (C-PTS) plan, named as M-PTS, to decrease the PAPR of OFDM signals. In this plan to figure the issue of PAPR lessening to join the purposed M PTS plan joined with the C PTS plan. In the C PTS utilized single quadrant yet as a part of M PTS utilized 4QAM and 16QAM and utilized four quadrant without side band data C PTS is send effectively transmit and recoup the stage movement of the subcarrier. The M PTS is not present the side data that is by M PTS has better band width efficiency and bit mistake rate when contrasted with C PTS plan.

2. Improved Peak Windowing for PAPR Reduction in OFDM: Guoguang Chen, RashidAnsari, Yingwei Yao(2009):-

OFDM framework execution corruption because of a low power efficiency and nearness of non straight power enhancement. In this paper to lessen this issue by the assistance of pinnacle windowing strategy with the assistance of In band and out band signal. The OFDM analysis the fluctuation is described by the PAPR that is know as a peak variable ($OFDM=CF2$). This is an element which can't transmit the side data and alteration of the receiver in this way, it overcome with the assistance of new pinnacle windowing plan to accomplish the better execution. Toward the end it accomplished through windowing plan, are "Relative group of stars error(RCE) and Small contiguous channel rate(ACPR)". This components enhance the execution and beat the fluctuations.

3. On Interference Avoidance through InterCell Interference Coordination (ICIC) Based on OFDMA Mobile Systems:Chrysovalantis Kosta , Bernard Hunt, Atta UI Quddus, and Rahim Tafazzol(2010):

(PAPR) plan in view of is utilized in UL LTE based frameworks. (e.g. MIMO). Through a progression of steps how the many-sided quality connected with the ICIC issue can be streamlined and comprehended in polynomial time. There is still an on-going examination push

to discover not so much unpredictable but rather more proficient incorporated ICIC utilizing these techniques.³

4. OFDM PAPR reduction by switching null subcarriers and data subcarriers: K.T. Wong, B.Wang and J complexity C. Chen(2011):-

This new approach requires no channel side data, can be good with existing measures, forces no rate hit, is distortionless, has low calculation al many-sided quality and can supplement most other PAPR decrease strategies. The proposed plan could be utilized with any multicarrier framework with invalid subcarriers. To minimize any debasement to the gatekeeper band, one

„innermost“ invalid subcarrier. Future work will take issues of utilization of the forecast comes about with the end goal of lessening PAPR diminishment utilizing numerous subcarrier.⁴

5. An Efficient Nonlinear Commanding Transform for Reducing PAPR of OFDM Signals: Y.Wang(2012):

Diminishment in PAPR and additionally an enhanced BER performance at the same time. Comes about exhibit that the proposed plan can significantly offer better general execution of OFDM framework as far as PAPR lessening, BER execution and transmission capacity proficiency. The SE and EE are expanded with an aggregate transmit power limitation over added substance white Gaussian clamor (AWGN) channel. The OFDM framework with PAPR decrease could accomplish higher SE and EE than the framework without PAPR reduction.⁵

6. Exponential companding technique for PAPR reduction in OFDM systems: Tao jiang,yonghua song, yang yang(2014):

μ -law companding for increment the normal force. companding plans can offer better PAPR lessening, Bit Error Rate (BER), and stage blunder execution than the μ -law companding plan. viably lessen PAPR for various regulation organizations and sub-bearer sizes.[6]

7. PAPR reduction in OFDM systems using peak insertion: Abdulreh manikramsiddiq(2015):

Crest Insertion (PI) is proposed in this paper. PI relies on upon the duality property of the DFT and PAPR duality of a motivation. PC reproduction tests demonstrate that a tradeoff can without much of a stretch be made amongst BER and the PAPR of the transmitted sign to accomplish a fancied framework execution. PAPR diminishment as

contrasted and other comparative systems which result in transmitted force² increase, and in this manner, it is by all accounts reasonable to be utilized for OFDM signal PAPR decrease.

4. PAPR Reduction Techniques

Different PAPR reduction schemes are basically described into two forms.

PAPR .This is reduced by the some techniques like

4.1 Signal scrambling scheme

Selected mapping (SLM)⁸⁻¹⁰, Partial Transmit Sequence (PTS)^{11,12}, clipping, CCDF (complementary cumulative distribution function) etc. are Signal Scrambling Techniques. Peak windowing.

4.1.1 Selective Mapping (SLM)

In this strategy the sign real transmit at the most reduced PAPR is chosen from an arrangement of various signs which are speaks to the same data SLM system are extremely adaptable as they don't force any confinement on the regulation which connected in the subcarriers or on their number. Piece chart of the SLM strategy

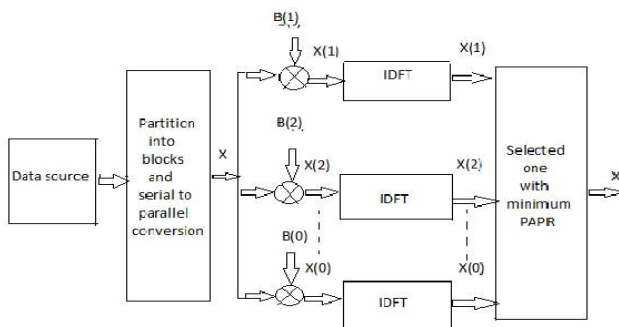


Figure 1. Block Diagram Of OFDM transmitter with SLM Technique¹³.

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

Let's define the data stream after serial to parallel conversion as written above expression,¹⁴

Where $n=0, 1, 2, \dots, N-1$,

According to this expression OFDM data block provide the same information as the unmodified OFDM data block provide the phase sequence.

SLM method effectively reduces the PAPR with any signal distortion but it has higher system complexity and computational Burden.

This complexity can less by reducing the number of IFFT block.

4.1.2 PTS Technique

Partial Transmit Sequence is widely used technique for PAPR reduction. The basic principle behind this scheme is addition of phase rotation to develop candidate signal and select one with low PAPR¹⁵.

Let input data blocks $X = \{X(k)\}$, where $(k = 1, 2, \dots, N-1)$, N is number of sub-carriers. Make N is the frequency domain

$$X = [X(0), X(1), \dots, X(N-1)] \quad (3)$$

By multiply the phase sequence.

$$P(k) = \{P(0), P(1), \dots, P(M-1)\} \quad (4)$$

With X element provide the following results

$$X^{(k)} = X \cdot P(k)$$

$$X = [X(0), X(1), \dots, X(N-1)] \quad (5)$$

Where $K, P^k = \exp(j\varphi^k)$, φ^k is uniformly distributed in $[0, 2\pi]$.

Get N candidate „s time domains using IDFT

$$X^{(k)} = \text{IDFT} \{X^{(k)}\} = (1, 2, \dots, N) \quad (6)$$

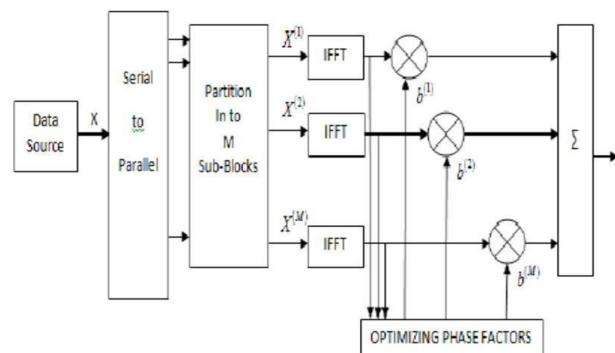


Figure 2. Block diagram of PTS technique¹⁶.

4.1.3 Clipping and Filtering

It is the most widely used technique of PAPR reduction which basically clip the parts of the signal and that are outside the allowed region¹⁷. For eg. High Power Amplifier (HPA). Mathematical Expression,

$$\begin{aligned} \{X, & \quad X \leq A \\ C(X) = & \\ \{A, & \quad X > A \end{aligned} \quad (7)$$

Where A_n is available cut-out level and it is sure genuine number. Transmitter is performed by the section the beneficiary need to evaluate the cut-out that has happened and repay the gotten OFDM image appropriately. There have two parameters which gauge at the recipient.

1. Location of the clip
2. Size of the clip

Sifting is utilized in the wake of section. It diminished the out of band radiation. Yet, in the wake of section it can't diminish in band twisting. However cutting may bring about some pinnacle regrowth so that the sign subsequent to section and sifting will surpass the cut-out level at a few focuses. The procedure continues rehashing until the required yield is not acquired. PAPR at expense of computational many-sided quality increment.

4.1.4 CCDF (Complementary Cumulative Distribution Function)

The PAPR, which is defined as the ratio between maximum peak power and the average power of the desecrate OFDM signal can be expressed as,¹⁸

$$PAPR = 10 \cdot \log_{10} \frac{\text{Max} \left[\left| s \left(\frac{nT_s}{N} \right) \right|^2 \right]}{E \left[\left| s \left(\frac{nT_s}{N} \right) \right|^2 \right]} \text{ (dB)} \quad (8)$$

Figure 3. Expression for CCDF in PAPR.

Where S is OFDM signal and E is statical expectation¹⁹

The CCDF is commonly used to evaluate the performance of PAPR reduction techniques. The CCDF of the

PAPR donates the probability that the PAPR of an OFDM symbol exceeds a threshold $PAPR_0$. We define the CCDF as, $CCDF = P(PAPR > PAPR_0)$

4.1.5 HPA (High Power Amplifier)

The OFDM collector location proficiency is an exceptionally delicate to the non-direct gadgets utilized as a part of its sign handling circle, for example, advanced to simple converter (DAC) and high power enhancer. This may seriously impede framework execution due to presented ghostly regrowth and identification proficiency degradation. For eg. Most radio framework representative the HPA in the transmitter to get adequate transmits power and the HPA is generally worked at or close to the immersion district which accomplished the greatest yield power productivity and therefore the memory less non-straight contortion because of high PAPR of the information signs will be brought into the correspondence channel. HPA is not worked in the straight locale with substantial force back off.

4.1.6 Peak Windowing

Top windowing is proposed the haphazardly created the parallel grouping information which is mapped into the QPSK images. The IFFT is tested to acquire the OFDM signal. Crest windowing is utilized for diminished the pinnacle estimation of the force of the sign with the assistance of PAPR decrease¹⁵. Top windowing alongside the cut-out methodology utilized for increment the edge level. When they consolidated each other, they created to got the low PAPR and enhance the BER. This is the most recent procedure to be utilized as a part of the OFDM for diminishing the PAPR. Numerically expressions required to be utilized hamming window, Kaiser window, hanning window and so on in the pinnacle windowing.^{20,21}

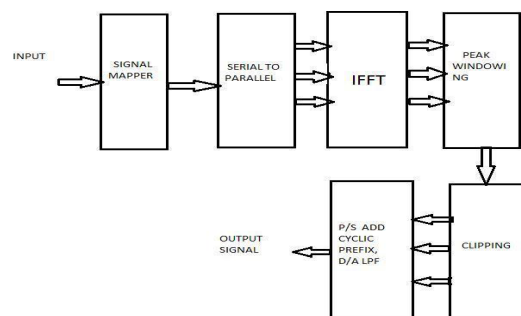


Figure 4. Proposed scheme for P APR reduction in OFDM system.²¹

5. Comparison of different PAPR reduction techniques²²

NAME OF SCHEME	NAME OF PARAMETERS			
	DISTORTION LESS	POWER INCREASES	DATA RATE LOSS	BER IMPROVED
PTS	YES	NO	YES	YES
CCDF	YES	NO	YES	YES
SLM	YES	NO	YES	YES
FILTERING	YES	YES	NO	YES
CLIPPING	NO	NO	NO	NO
HPA	NO	YES	NO	NO

6. Conclusion and Future Work

OFDM is an exceptionally appealing procedure for remote correspondence because of its range proficiency and channel vigor one of the genuine downsides of in OFDM framework is that the composite transmit sign can show a high PAPR when the information arrangements can profoundly connected. In this paper, we depicted a few imperative angles, and also give a numerical expression, the conveyance of the PAPR in OFDM frameworks. six run of the mill strategies to lessen the PAPR have been broke down, all of which can possibly give a considerable diminishment in the PAPR at the expense of misfortune in information rate, transmit signal, influence increment, BER, execution debasement, computational multifaceted nature increment, et cetera. The most capable method is psychological radio; likewise demonstrate that it is conceivable to decrease the PAPR of for multi-client OFDM systems. IN this paper the highlighted procedure is pinnacle windowing ,this is PAPR lessening plans adequately constrict the PAPR and it can give a superior results .tentative arrangements are chipping away at PAPR diminishment completely expelled from the OFDM.

7. References

1. Dash AA. OFDM systems and paper reduction techniques in OFDM systems. PhD Thesis. 2010.
2. Gupta K et al. PAPR reduction of OFDM using a new phase sequence in SLM technique, IEE. 2013; 2(2):125–9.
3. Kosta C, Hunt B, Quddus AUI, Tafazolli R. A new peak-to-average power-ratio reduction algorithm for OFDM systems via constellation extension. IEEE Trans.
4. Wang Y. PAPR reduction of an OFDM signal by use of PTS with low computational complexity. IEEE Trans Broadcasting. 2006 Mar; 52(1):83–6.
5. Baxley RJ, Tong Zhou G. Comparing selected mapping and partial transmit sequence for PAR reduction. IEEE Trans Broadcasting. 53(4):797–803.
6. Jones DL. Peak power reduction in OFDM and DMT via active channel modification. Proceedings of 1999 Asilomar Conference. 1999.
7. Taojiang yonghua song, yang yang “Comparing selected mapping and partial transmit sequence for PAR reduction,” IEEE Trans. Broadcasting, vol. 53, no. 4, pp. 797–803,
8. Kaur G et al. Compare SLM (selective mapping) and PTS (partial transmit) technique for PAPR reduction of an MC-CDMA (multi-carrier complex division multiple access). IEEE. 2012 Jul-Aug; 2(4):779–84.
9. Guangyue L et al. Partial Transmit Sequences Method for Reduction of PAPR in Real-Valued OFDM Systems. Signals and Systems Division, Dept of Engineering Sciences, Uppsala University Uppsala, Sweden.
10. Abdullah MI et al. Comparative Study of PAPR Reduction Techniques in OFDM. ARPN journal of system and software. 1.
11. Han SH, Lee JH. An Overview of Peak-To-Average Power Ratio Reduction Transmission. IEEE Wireless Communications. 2005 Apr; 12(2):56–65.
12. Gupta K et al. PAPR reduction of OFDM using a new phase sequence in SLM technique. IJAEEEE. 2013; 2(2):125–09.
13. Juwano FH. et al. PAPR reduction using Huffman coding combined with clipping and filtering for OFDM transmitter to mitigate PAPR(peak-to-average power ratio) in OFDM”(CITISIA 2009). 2009; 8.
14. Müller SH, Huber JB. A Novel Peak Power Reduction Scheme for OFDM. Proc IEEE PIMRC '97, Helsinki, Finland. 1997 Sep; 1090–94.
15. Zhang,JQ, Kokkeler ABJ, Smit GJM. An Oversampled Filter Bank multicarrier System for Cognitive Radio. IEEE international symposium on personal, mobile radio communications (PIMRC08). Cannez France, 2008 Sep 1–5; 15–8.
16. Neill O, Lopes. Envelope variations and spectral splatter in clipped multicarrier signals. Proc IEEE PIMRCa95. 1995; 71–5.
17. Lim D, No J, Lim C, Chung H. A new SLM OFDM scheme with low complex PAPR reduction. IEE Process Let. 12(2):93–6.

18. Van Nee R, De Wild A. Reducing the peak -to- average power ratio of OFDM. Proc IEEE Vehicular Technology Conference. 1998 May; 3:2072–6.
19. Annstrong. Peak-to-average power reduction for OFDM by repeated clipping and frequency domain filtering. Electron Lett. 2002 Feb; 38(5):246–7.
20. Sakran HY, Shokair M, Elazm AA. An efficient technique for reducing PAPR of OFDM system in the presence of nonlinear high power amplifier. Progress in Electromagnetics Research, PIER C. 2008; 2:233–41.
21. Pauli M, Kuchenbecker P. On the reduction of the out-of-band radiation of OFDM-signals. Proc IEEE International Conference on Communications. 1998 Jun; 3:1304–8.
22. Kim D-K, Shi D-J, Park Y-S, Song B-G. New peak-windowing for PAPR reduction of OFDM systems. APWCS. 2005 Aug; 169–73.