

# Performance of PAPR Reduction in OFDM Based Wireless Communication using OICF system

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**Abstract-** Orthogonal frequency division multiplexing has emerged as a leading candidate for a key technology in a variety of wireless communication systems in recent years. In particular, OFDM has been accepted as a standard for a variety of wireless communication systems, including DAB and DVB, wireless local area networks, wireless metropolitan area networks, and wireless local area networks. In this article, we have covered a variety of topics concerning PAPR, including reduction approaches and a discussion of PAPR concerns. The power amplification product ratio, or PAPR, is defined as the relation between the maximum powers of a sample in a particular OFDM transmits symbol and the average power of that OFDM symbol. PAPR is triggered if a multi-carrier system has sub-carriers that are out of phase with one another. The simulation results show that our proposed power reduction technique OICF was proposed to reduce the high Peak to Average Power Ratio values. The Simulations are performed using the OICF technique with modulation technique under both Additive White Gaussian Noise channels. The simulation result shows the relationship between Complementary Cumulative Distribution Function versus PAPR. The simulation is performed by MATLAB R2013a.

**Keywords-** AWGN, PAPR, Modulation, CCDF, BER, SNR, OICF, ICF.

## I. INTRODUCTION

The wireless communication history, every generation of computers get advanced with new frequency bands, high data speeds, and transmission technology that is not compatible with earlier versions. In this regard, as is well knowledge, 4G is the successor to 3G; that is, 4G makes broadband internet access available on computers and other mobile devices. Accessing mobile internet, video conferencing, video calling, and high-definition mobile TV are some of the other capabilities that are included in it.

Additionally, IP telephony and video conferencing are also included (Voice over Internet Protocol [VIOP] it is the group of technologies which is used to deliver the voice communication through the internet protocol). LTE, which stands for "Long Term Evolution" and was introduced in Norway and Oslo in 2009, and Mobile WiMAX are the two varieties of 4G technology (firstly used in South Korea in 2006). After 2008, WiMAX was first put into operation. The article that was presented suggested several approaches for reducing PAPR by combining QCA modulation technology with AWGN.

As a result, line monitoring and protection are very significant components. Figure 1.1 depicts the network that is used by the WiMAX system. It is composed of two distinct infrastructures, one for protection and the other for monitoring.

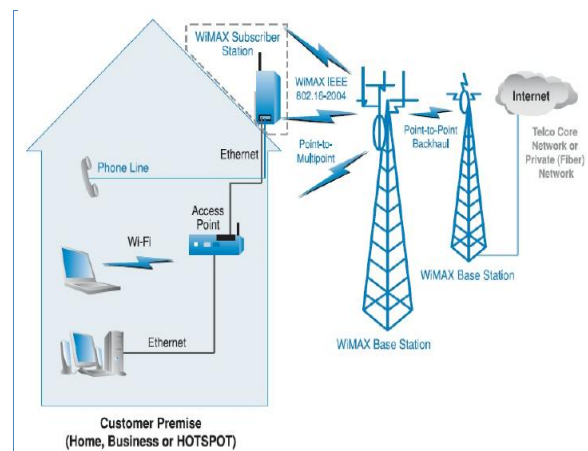


Fig 1. WiMAX Structure.

- WiMAX subscriber station,
- WiMAX Base station.

## II. PAPR

Peak to average power ratio (PAPR) is a signal property that is calculated by dividing the peak power amplitude of the waveform by the RMS value of it, a dimensionless quantity which is expressed in decibels (dB). In digital transmission when the waveform is represented as signal samples, the PAPR is defined as in equation 1.

$$\text{PAPR} = \max(|S[n]|^2) / E\{|S[n]|^2\}, 0 \leq n \leq N-1 \quad (1)$$

Where  $S[n]$  represents the signal samples,  $\max(|S[n]|^2)$  denotes the maximum instantaneous power and  $E\{|S[n]|^2\}$  is the average power of the signal [1].

### 1. PAPR reduction techniques:

There are different techniques to reduce PAPR of OFDM.

- Partial Transmission Sequence(PTS),
- Selective Mapping(SLM),
- Tone Reservation,
- Iterative clipping and filtering

#### 1.1 Iteration Clipping and Filtering:

After clipping, the concept of filtering the emissions of neighbouring channels is discussed in [2]. Because applying filtering on clipped signals causes the formation of new peaks, the approach of repeatedly applying clipping and then applying filtering has subsequently been presented in [3] and [4]. This technique uses the zero padding of the signal in the frequency domain and frequency domain filtering of the clipped signal at the output of the IFFT. Both of these operations take place in the frequency domain.

The clipping and filtering procedure is carried out a number of times, namely between four and five times according to the author's tests. These repeats lead to a significant increase in the amount of signal processing that is required, since each frequency domain filtering requires a pair of FFT and IFFT operations. Its performance in reducing PAPR is becoming closer and closer to that of the PAPR reduction performance of the repeated clipping and filtering technique with an adjustable number of repetitions.

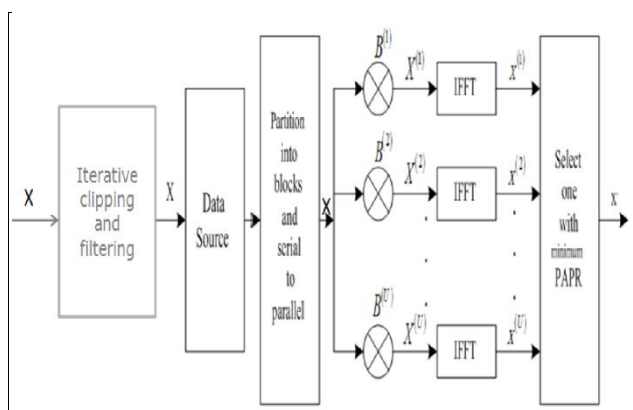


Fig 2. Block diagram of the proposed method.

#### 1.2 Optimized-Iteration-Clipping-Filtering (OICF) Scheme:

As was discussed before, in order to acquire the clipped signal that you wish, it is required to perform iterative clipping and filtering (ICF), which consists of  $2K+1$  IFFT/FFT operations.  $K$  is the number of iterations. Presented an ICF method that is both effective and quick to execute. One iteration (consisting of four IFFT/FFT operations) was performed in order to generate the desired

clipped signal, and some further processing was also carried out (two vector subtractions). They made the assumption that the clipped peaks were a sequence of parabolic pulses, which is correct for clipping thresholds that are quite big. Due to the fact that the original OFDM data block was oversampled (by a factor of 4), there is a possibility that the processing overhead is still rather significant. A brand new method known as one iteration of clipping and filtering (OICF) is going to be discussed in this section.

This strategy, as the name suggests, delivers the clipped signal that is needed with a single repetition that requires essentially no extra processing. The OICF technique makes use of a scaling of the clipping threshold that was originally used. An empirical equation that links the original clipping threshold to the new scaled one has been produced by us. This expression is based on the regrowth of clipped-filtered pulses, and it was determined empirically.

The findings of the simulation indicate that the performance of OICF is on par with that of the traditional approach when the clipping threshold is set to a high value. As was discussed before, in order to acquire the clipped signal that you wish, it is required to perform iterative clipping and filtering (ICF), which consists of  $2K+1$  IFFT/FFT operations.  $K$  is the number of iterations. Presented an ICF method that is both effective and quick to execute. One iteration (consisting of four IFFT/FFT operations) was performed in order to generate the desired clipped signal, and some further processing was also carried out (two vector subtractions). They made the assumption that the clipped peaks were a sequence of parabolic pulses, which is correct for clipping thresholds that are quite big. Due to the fact that the original OFDM data block was oversampled (by a factor of 4), there is a possibility that the processing overhead will still be significant.

### III. LITERATURE SURVEY

[1] Goel, A., and Mathur, P., "Companding Schemes for Reducing PAPR in OFDM System: A Review," Journal of Optical Communications, 2018, <https://doi.org/10.13b64/JOC-2017-0024>. In this research, we have undertaken an investigation into companding approaches and analysed the PAPR and BER performances of the various schemes that were investigated. For the purpose of this comparison, we have thought about the  $\mu$ -law companding, the exponential companding, the trapezoidal companding (TC), and the trigonal companding. We have shown in this paper that the  $\mu$ -law companding, exponential companding, and trigonal companding schemes have no adaptability in designing the companding function. As a result, it is impossible to achieve a trade-off between BER performance and PAPR reduction ability.

[2] **Lahcen Amhaimar, Saida Ahyoud, Ali Elyakoubi, Abdelmoumen Kaabal, Kamal Attari and Adel Asselman "PAPR Reduction Using Fireworks Search Optimization Algorithm in MIMO-OFDM Systems,"** Journal of Electrical and Computer Engineering, 2018, Article Title: "PAPR Reduction Using Fireworks Search Optimization Algorithm" In this article, a PTS method with decreased computational cost is suggested. The scheme is based on an innovative swarm intelligence algorithm known as the fireworks algorithm (FWA). The suggested technique has been shown to be adequate and effective based on the results of the simulations. The proposed method is able to successfully minimise the computing complexity while maintaining a satisfactory PAPR reduction. In addition to this, the results show that the proposed PTS scheme-based FWA performs noticeably better than some of the most popular and significant evolutionary algorithms that have been discussed in the research community, such as simulated annealing (SA), particle swarm optimization (PSO), and genetic algorithm (GA).

[3] **P. Preenu Ann; Renu Jose "A comparison of different techniques for lowering PAPR in OFDM systems"** OFDM modulation techniques provide a number of benefits for multicarrier transmission at high data rates. These benefits were presented at the 2016 IEEE International Conference on Communication and Electronics Systems (ICCES). One of the most significant drawbacks of OFDM is that it results in a high Peak-to-Average Power Ratio (PAPR) of the transmitted signal, which has a negative impact on the complexity of power amplifiers. Several potential methods have been suggested and put into practise in an effort to lower the PAPR of an OFDM signal. However, these methods come at the penalty of increased complexity, transmitted signal power, and bit error rate (BER).

In this study, the PAPR reduction of an OFDM signal at the transmitter is accomplished using clipping and filtering, selective mapping (SLM), partial transmit sequence (PTS), linear block coding (LBC), and peak insertion (PI) methods. The performance of the system in terms of CCDF and BER is used as a comparison factor for evaluating various PAPR reduction strategies.

[4] **Pedro F. G. da Silva, Eduardo G. de Lima "Design of Crest Factor Reduction Techniques for Wireless Communications Systems,"** focuses on the use of clipping and filtering in the process. 2014 IEEE, Crest factor reduction, often known as CFR, is a method that is frequently used for the linearization of power amplifiers (PAs) in mobile communication systems. It was one of the topics covered in this study. The most important thing that this study has contributed is the establishment of criteria for deciding whether or not it is beneficial to linearize a PA by making use of a CFR that is derived from a hard clipping limiter and is then followed by a

filter. The criteria is then confirmed by computational simulations that are run on a PA that is represented by a Wiener cascade and activated by a 4GPP WCDMA signal that has a PAPR of 12 dB. These simulations are run on a PA that is modelled by a Wiener cascade. An increase of 1.8 dB in the average output power is evidence that the criteria in this case suggest that the use of CFR is advantageous. This is shown by the fact that the average output power increased. Validation of the criteria is accomplished by running numerical simulations on a PA that is represented as a Wiener cascade and is aroused by a 4GPP WCDMA signal that has a PAPR of 12 dB.

In this particular illustration, it was found that, even without the application of linearization, there was still available margin in the in-band measure; hence, the use of CFR was found to be acceptable in accordance with the criteria. Furthermore, it is achieved an increase of 1.8 dB in average output power with the inclusion of the CFR approach. This is in comparison to the scenario when there was no linearization, which confirms that the criteria are accurate.

[5] **"Ultimate Performance of Clipping and Filtering Techniques for PAPR Reduction in OFDM systems,"** by Xiaodong Zhu, an IEEE Member; Jinxiang Xia; Hong Li; and Haichao Hu Fundamentals and PHY was the topic of discussion at the 2014 IEEE 24th International Symposium on Personal, Indoor, and Mobile Radio Communications. Track, in this article, clipping and filtering are construed as a process that involves include an additional signal in addition to the original signal. On the basis of this, the issue of achieving the ultimate performance of clipping and filtering methods may be stated as a convex optimization problem. By successfully addressing this problem, we are able to achieve the ultimate performance of these techniques.

After that, we analyse the performance of a number of well-known clipping and filtering procedures using this ultimate performance, and then we provide the simulation findings. The values of EVM that can be produced using ICF, SICF, and PC-CFR approaches for a particular PAPR are shown below in their respective forms. The least EVM that may be attained by solution is denoted by the curve that is labelled "Ultimate Performance."

In this instance, the EVM is determined by computing the root mean square of the EVM for 104 randomly selected OFDM signals. Because for PAPR values greater than 4.5 dB, the three approaches of clipping and filtering have the potential to provide the best possible performance. In spite of this, there is a gap between the three approaches and the ultimate scenario when the PAPR is less than 4.5 dB, and the size of this gap grows as the PAPR becomes smaller. Out of the three methods, SICF provides the performance that is the least desirable, whereas PC-CFR displays the performance that is most desirable.

#### IV. OVERALL ANALYSIS OF DIFFERENT TECHNIQUES

The PAPR reduction technique should be chosen with awareness according to various system requirements as shown in table 1.

Table 1. Comparison of PAPR Reduction Techniques.[16]

Reduction Technique	Parameters			Operation required at Transmitter (TX) / Receiver (RX)
	Decrease distortion	Power raise	Defeat data rate	
Clipping and Filtering	No	No	No	TX: Clipping RX: None
Selective Mapping (SLM)	Yes	No	Yes	TX: M times IDFTs operation RX: Side information extraction, inverse SLM
Block Coding	Yes	No	Yes	TX: Coding or table searching RX: Decoding or table searching
Partial Transmit Sequence (PTS)	Yes	No	Yes	TX: V times IDFTs operation RX: Side information extraction, inverse PTS
Inter leaving	Yes	No	Yes	TX: D times IDFTs operation, D-1 times interleaving RX: Side information extraction, de-interleaving

#### V. RESULT

##### 1. Analysis parameter in PAPR Reduction:

We are considered following analysis parameter in reduction of peak to average power ratio or power reduction as shown in the table 2.

Table 2. Analysis parameter in PAPR Reduction.

S. No.	Parameter	Value
01	OFDM	128 subcarriers
02	Modulation	QPSK, 8-QAM
03	Channel	AWGN & Raylight
04	Oversampling Factor	4
05	Claping Ration	2.10

##### 2. PAPR Reduction Performance for QPSK:

In this performance we are used different-different subcarriers (N=64, and 128) with QPSK-Modulation, also considered claping ration (CR)  $\gamma$  is still set to 2.11, L=4, PAPR with OFDM signal. Figure 3 for N=64, figure 4 for N=128 shows the PAPR, CCDF curves for the signals processed by using the original and simplified OICF algorithms, respectively.

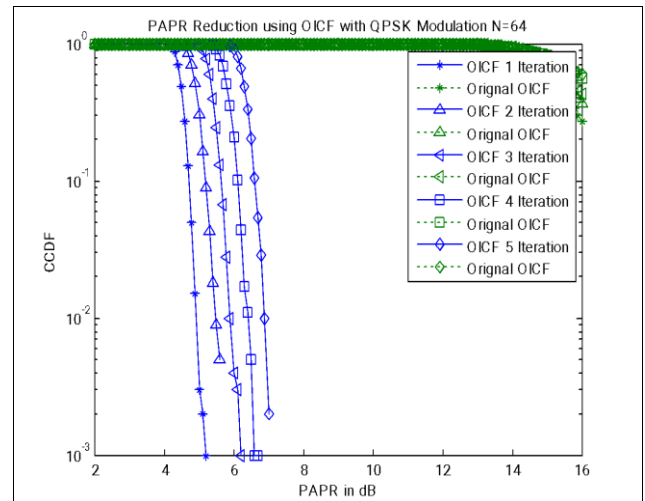


Fig 3. PAPR Reduction performance of original and simplified OICF algorithms, QPSK, N=64 subcarriers, L=4 and  $\gamma=2.11$ .

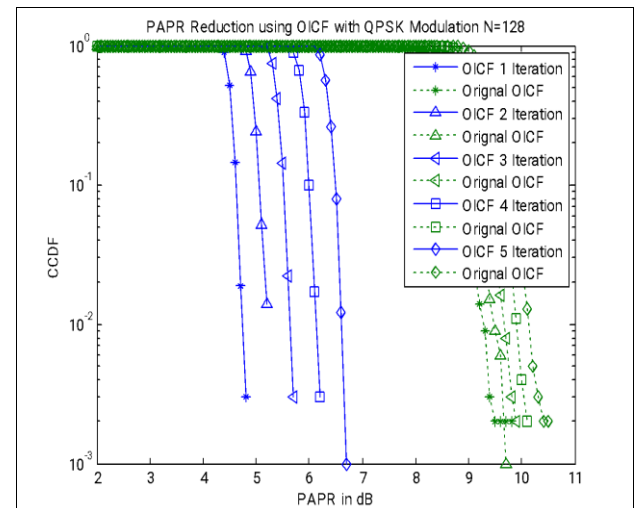


Fig 4. PAPR Reduction performance of original and simplified OICF algorithms, QPSK, N=128 subcarriers, L=4 and  $\gamma=2.11$

##### 3. PAPR Reduction performance for 8-QAM:

In this performance we are used different-different subcarriers (N=64, and 128) with 8-QAM-Modulation, also considered claping ration (CR)  $\gamma$  is still set to 2.11, L=4, PAPR with OFDM signal. Figure 5 for N=64, figure 6 for N=128, shows the PAPR, CCDF curves for the signals processed by using the original and simplified OICF algorithms, respectively.

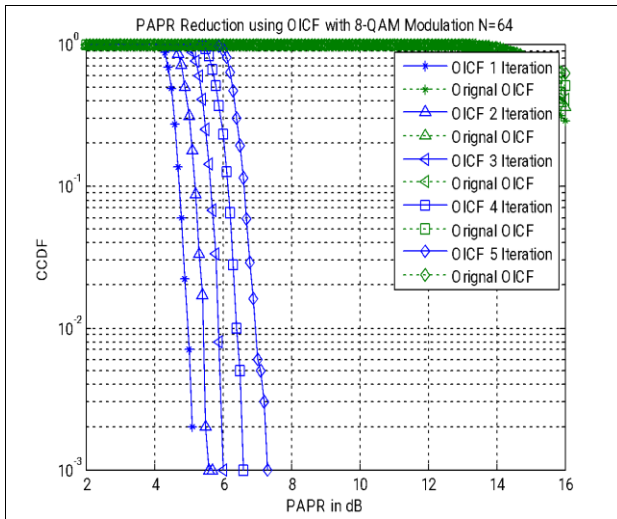


Fig 5. PAPR Reduction performance of original and simplified OICF algorithms, 8-QAM, N=64 subcarriers, L=4 and  $\gamma=2.11$

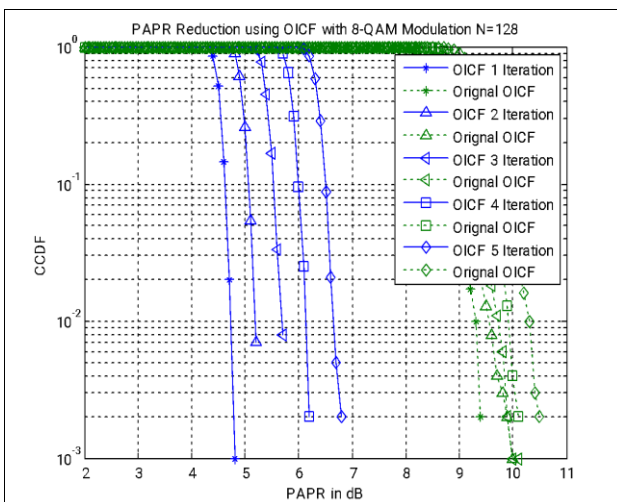


Fig 6. PAPR Reduction performance of original and simplified OICF algorithms, 8-QAM, N=128 subcarriers, L=4 and  $\gamma=2.11$

## VI. CONCLUSION

The orthogonal frequency division multiplexing (OFDM) method is quickly becoming one of the most popular options for the transmission of high-speed data across a communication channel. This method is particularly useful for multicarrier transmission. It has a number of benefits; nevertheless, there is one significant negative, and that is the fact that it has an extremely high PAPR. OFDM is a very attractive technique for wireless communications due to its spectrum efficiency and channel robustness.

One of the serious drawbacks of in OFDM systems is that the composite transmit signal can exhibit a very high PAPR when the input sequences are highly correlated. In this thesis, the different properties of an OFDM System

are analyzed and the advantages and disadvantages of this system are understood.

## REFERENCES

- [1] Mohammad Abdul Raqeeb; Analysis of Various PAPR Reduction Techniques in OFDM System, International Journal of Innovative Technology and Exploring Engineering, Vol. 8(7), 2019.
- [2] Ali Jasim Ghaffoori; PAPR Reduction in OFDM System Using Adaptive Hybrid Technique, IOP Conf. Series: Materials Science and Engineering, Vol. 518, 2019.
- [3] Isha Goel; A Review: Analysis of PAPR Reduction Techniques of OFDM System, Res Dev Material Sci, Vol. 8 (3), 2019.
- [4] Kelvin Anoh and Bamidele Adebisi; A New Approach to Iterative Clipping and Filtering PAPR Reduction Scheme for OFDM Systems, IEEE Access, Vol. 6, 2018.
- [5] H. Chen, H. Liang; Combined Selective Mapping and Binary Cyclic Codes for PAPR Reduction in OFDM Systems, IEEE Transactions on Wireless Communications, vol.6, no.10, Oct. 2007.
- [6] G. Hill; Peak Power reduction in Orthogonal Frequency Division Multiplexing Transmitters, in school of Communication and Informatics: Victoria University, March 2011, p.13.
- [7] S. H. Han and J. H. Lee; An overview of peak-to-average power ratio reduction techniques for multicarrier transmission, IEEE Wireless Comm. Mag., vol. 12, pp. 56–65, Apr. 2005.
- [8] Kelvin Anoh and Bamidele Adebisi; A New Approach to Iterative Clipping and Filtering PAPR Reduction Scheme for OFDM Systems, IEEE Access, Vol. 6, 2018, pp. 17533-17544.
- [9] Mohamed Mounir; On the Effectiveness of Deliberate Clipping PAPR Reduction Technique in OFDM Systems, IEEE- 2017, Japan-Africa Conference on Electronics, Communications and Computers (JAC- ECC).
- [10] Garima Tare and Mahesh Gaud; Performance Analysis of the Partial Transmit Sequence using modified Clipping Algorithm for PAPR reduction in OFDM, International Journal of Scientific & Engineering Research (IJSER), Vol. 8(4), 2017.
- [11] Kavita Mhatre and Uday Pandit Khot; Efficient Selective Mapping PAPR Reduction Technique, Elsevier, Science direct, International Conference on Advanced Computing Technologies and Applications (ICACTA-2015), Procedia Computer Science 45, pp. 620 – 627.
- [12] Kapil Sahu and K.T.Veeramanju; PAPR Reduction in OFDM System using Iterative Clipping and Filtering technique along with Convolutional Code”, IEEE-2015, Fifth International Conference on Communication Systems and Network Technologies.