iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** I **Month of publication:** January 2017

DOI:

www.ijraset.com
IC Value: 13.98
Volume 5 Issue I, January 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A Survey on PAPR Reduction Methods for OFDM System

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Abstract*: Orthogonal Frequency Division Multiplexing (OFDM) which falls under the multi carrier modulation category. OFDM has gain popularity in number of applications in wireless networks. A very desirable factor in most application is high data rate. Even though OFDM is used as a standard all over the world in order to provide users with high data rates followed by advanced intensive applications wirelessly, bit it faces various challenges like Peak to Average Power Ratio(PAPR), The PAPR problem in OFDM signal can be considered as a big drawback in the high data rate and bit transmission in the signal due to its unstable spikes and behavior. There are various techniques to overcome the problem of PAPR like Partial Transmit Sequence, Selective Level Mapping, Block Coding, Clipping and Filtering, Tone Injection. In this paper several techniques have been discussed for PAPR reduction.
Keywords*: Multicarrier, Orthogonal Frequency Division Multiplexing, Peak to Average Power Ratio, Clipping, Partial Transmit Sequence.

I. INTRODUCTION

Wireless communications have been around a century and have found developments the entire round. Modulation being the fundamental to all wireless communication is the process of impressing the data with respect to the characteristics of high frequency carrier [1]. In single carrier modulation, the data is transmitted using a single radio frequency (RF) carrier wave and in multi carrier modulation, the data is transmitted by simultaneously modulation with multiple radio frequencies (RF) carrier wave. In this paper, the study is mainly focused on an Orthogonal Frequency Division Multiplexing (OFDM) which falls under the multi carrier modulation category. OFDM has gain popularity in number of applications in wireless networks. It also has a strong contribution in the fourth generation of cellular mobile communication [2]. Though OFDM has many advantages like robustness, capacity to handle very strong echo's, high spectral efficiency and non-linear distortion. But it also has a disadvantage of high Peak to Average Power Ratio (PAPR). It is necessary to reduce PAPR otherwise it degrades the system performance. There are lots of techniques to limit the PAPR problem. Some of which are given in below section[3]. This paper focuses on the research done by various researchers in the field of PAPR reduction of OFDM system and the results are summarized in tabular form. The rest of the paper is organized as follows: Section II gives the brief introduction of PAPR problem section III presents the work done by researchers, section IV concludes the paper followed by references.

II. PEAK TO AVERAGE POWER RATIO

OFDM has a drawback in the sense that it exhibits high Peak to Average Power Ratio (PAPR) due to the time-domain superposition of many data subcarriers, that is, when N signals are added with the same phase, they produces a peak power which is N times greater than the average power[4-5]. When this high PAPR signals are amplified by practical power amplifiers that have non-linear response and finite amplitude ranges, non-linear distortions on the communication will occur. This non-linear distortion creates out-of-band distortion which interferes with co-channel users and in-band-distortion that causes self–interference. To overcome non-linear distortions, transmit power amplifier has to be operated in its linear region with a large dynamic range. But linear Power Amplifiers are power inefficient and expensive too. In fact high cost of practical networks is due to use of high power linear amplifiers. Also large PAPR demands for D/A converters with large dynamic range to accommodate the large peaks of the OFDM signals and high precision DAC supports high PAPR but at higher cost. Thus large PAPR increases the complexity of D/A and A/D converters. Therefore reduction of Peak to Average Power Ratio is of major concern [6].
In general, Peak to Average Power Ratio (PAPR) of the OFDM signal is defined as the ratio between the maximum instantaneous powers of the signal to its average power.
Mathematically it can be expressed as

$$PAPR[X(t)] = \frac{P_{PEAK}}{P_{AVERAGE}} = 10\log_{10}\frac{\max[|X(n)|^2]}{E[|X(n)|^2]} \tag{1}$$

Where,
P_{PEAK} = Peak Output Power
$P_{AVERAGE}$ = Mean Average Output Power
E[.] = Expected Value
X(n) = Transmitted OFDM signals obtained after IFFT operation on modulated input symbols.

In the past recent years a variety of techniques have been proposed to reduce PAPR. These techniques are divided mainly into two groups - signal scrambling techniques and signal distortion techniques. Signal scrambling techniques includes all variations on how to scramble the codes in order to decrease the PAPR. These techniques include Block Coding Techniques, Selected Mapping (SLM), Partial Transmit Sequence (PTS), Interleaving Technique, Block Coding Scheme with Error Correction. On the other hand Signal Distortion Techniques reduces the peak directly by distorting the signal before amplification. Distortion techniques available are Peak Windowing, Companding, Clipping and Filtering and Envelope Scaling.

III. REVIEW OF TECHNIQUES TO GENERATE A SIGNAL WITH LOW PAPR

In the literature there are many techniques to generate a signal with low PAPR. Several requirements for PAPR reduction includes the compatibility with existing modulation schemes and should give high spectral efficiency. Low complexity is also required with high average power. The BER degradation and data rate loss should be avoided. Yingzi *et al.* (2003) explained in his research paper about the Golay code as the spreading code and compare and analyzed it with the Walsh Hadamard code to get the PAPR cumulative and complementary distribution function of MC-CDMA[7]. The results shows that the use of Golay code as spreading code can reduce the high PAPR of WH code for the uplink MC-CDMA from the level of 12dB to 9dB. So this technique reduces the PAPR but does not affect the performance of BER. Yang and Alsusa (2007) introduced a new method of Post-IFFT Amplitude Transforming (PIAT) that propose a randomizing procedure in the power spectrum directly and then produces a corresponding amplitude coefficient code for the time domain signal[8]. This results into multiple IFFT units and large amount of computational process and finding of code can be reduced and thus minimized the system complexity. In comparison with the ordinary simple SLM technique, the PIAT technique has low complexity as well as a better overall PAPR reduction ability as compared to the typical SLM technique. Houshou *et al.* (2007) proposed that 16-QAM and 64-QAM can be constructed using Golay complementary sequences. Large Euclidean distance and low PAPR for 16-QAM and 64-QAM is obtained by combining Golay complementary sequences and block coded modulation[9].

Tigrek *et al.* (2007) proposed a paper in which relation between sequences with equal PAPR are inspected. Then the author used Golay complementary pairs of codes and find the PAPR below 2 dB[10]. When the carriers increases in number, it generates the Golay codes with low PAPR which is below 2 dB covers a lesser portion of the all the sequences. Some of the codes are excluded which further reduce the date rates and finally affect the throughput of the OFDM system. High data rate can be achieved by using larger PAPR threshold. Urban, J. (2008) also discusses the PAPR reduction method with bounded distortion to generate better noise immunity with reduced complexity[11]. Kasiri and Dehghian (2009) stated that in SLM method, input data block is introduced to scrambling by U different phase sequences which further produces new sequences and out of those the one with low PAPR is chosen for data transmission[12].

In this paper (Bakhshi *et al.*, 2009) a technique of reducing PAPR by mixing SLM and Golay complementary sequences has been introduced. The Golay complementary sequence are used to reduce PAPR up to an optimal level by dividing the second order Reed-Muller code into cosets so that codewords with higher values of PAPR are separated from the others[13]. Then SLM technique is used after coding to use all the possible cosets, which results in an increase in the code rate as well as reducing the PAPR. In this paper separate carriers are used which shows the improvement in PAPR reduction and code rate. Scott. *et al.* (2010) discussed that uncoded OFDM systems have a serious drawback of high PAPR but on the other hand coded OFDM systems can reduce the problem of PAPR to a greater extent but at the cost of low code rate. Thus there is a trade-off between PAPR and code rate. This paper proposed four new families of 64-QAM sequences and seven new families of 256-QAM to achieve minimum PAPR value, higher code rate or the trade-off between them. A comparison with other OFDM 16- or 64-QAM sequences facilitates that these novel families of OFDM sequences have higher values of code rate and one can adjust the level of trade-off between PMEPR and code rate to either decrease the PAPR or increase the code rate as per the requirement of the systems[14]. Mukunthan (2011) also proposed a method in which the use of forward error correction codes such as Turbo codes and Golay codes are implemented

Volume 5 Issue I, January 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

to reduce PAPR and it is combined with modified PTS scheme. This approach significantly reduces the PAPR with minimum computational complexity as compare to the original PTS system used in MIMO-OFDM system. Turbo PTS provides a good PAPR reduction but as the number of sub carriers increases, performance decreases. On the other hand, Golay PTS provides 50% of PAPR reduction compared to that of Turbo PTS by using N=256 and dividing the subcarrier into 4 subgroups[15]. Rezgui *et al.* (2012) proposed a technique of reducing the PAPR by utilizing the advantage of Fractional Fourier transform (FRFT) in terms of linearity and weak correlation of noise and signal for particular time frequency space. Without any additional complexity, a special encoder that consists of low order Golay coder with special FRFT block offers minimum PAPR .When the channel is time-invariant, multicarrier modulation scheme uses traditional Fourier Transform. However, when the channel is time-varying, the traditional Multicarrier system loses optimality because optimal recovery operator is generally time-variant and hence cannot be implemented in the conventional Fourier domain .Therefore this arises the need of FRFT-based technique[16]. Sappal et al.(2013) presented the reduction of PAPR of 64-QAM signal. Results show that PAPR of the uncoded OFDM signal can be reduced using Golay complementary sequences and construction of 64-QAM signal using Golay codes has been presented. It has been explicated that a 64-QAM constellation can be written as a vector sum of 3 QPSK constellations respectively. Further it has been investigated that by using these sequences, PAPR is bounded above by 6.69dB. The techniques developed can be applied to generate OFDM sequences with low PAPR and large squared Euclidean distance for 256 or 1024-QAM constellations because 256-QAM or 1024-QAM can also be written as vector sum of four or five QPSK respectively[17]. From the above mentioned paragraphs, the strengths and weaknesses of some relevant papers are given in the tabular form as Table I.

TABLE I
STRENGTHS AND WEAKNESSES OF SOME RELEVANT PAPERS

AUTHOR	Year	TOPIC	STRENGHTS	WEAKNESS
Luan Yingzi et al.	2003	Performance Analysis of PAPR in MC-CDMA Using Golay Code	No BER degradation	
R.FiratTigrek et al.	2007	A Golay Code Based Approach to Reduction of the PAPR and its Consequence for the Data Throughput	Suitable for small number of carriers	Need to have large PAPR threshold, loss of data rate reduces communication capacity.
Lin Yang and Emad Alsusa	2007	Novel Low-Complexity Post-IFFT PAPR Reduction Technique by Utilizing Amplitude Transforming for OFDM Systems	Reduced Complexity	Restriction to the number of Subcarriers
Josef Urban	2008	PAPR Reduction in OFDM Systems by Simplified Clipping and Filtering with Bounded Distortion	Better Noise Immunity & reduced complexity	PAPR at the cost of worst BER
K. Kasiri and M.J. Dehghian	2009	A Blind SLM Scheme for reduction of PAPR in OFDM systems	Better PAPR reduction capability	Huge Complexity because of many IFFT stages
Hamidreza Bakhshi et al.	2009	Peak-to-Average Power Ratio Reduction by Combining Selective Mapping and Golay Complementary Sequences	Code rate high, error correction capability	Requirement of side information(SI)
Scott et al.	2010	Novel PMEPR Control Approach for 64- and 256-QAM Coded OFDM Systems	Better reduction of PAPR	
P.Mukunthan	2011	Modified PTS with FECs for PAPR reduction in MIMO-OFDM system with different subcarriers	Better PAPR reduction capability with reduced computational complexity	As the number of carrier increases, PAPR increases.

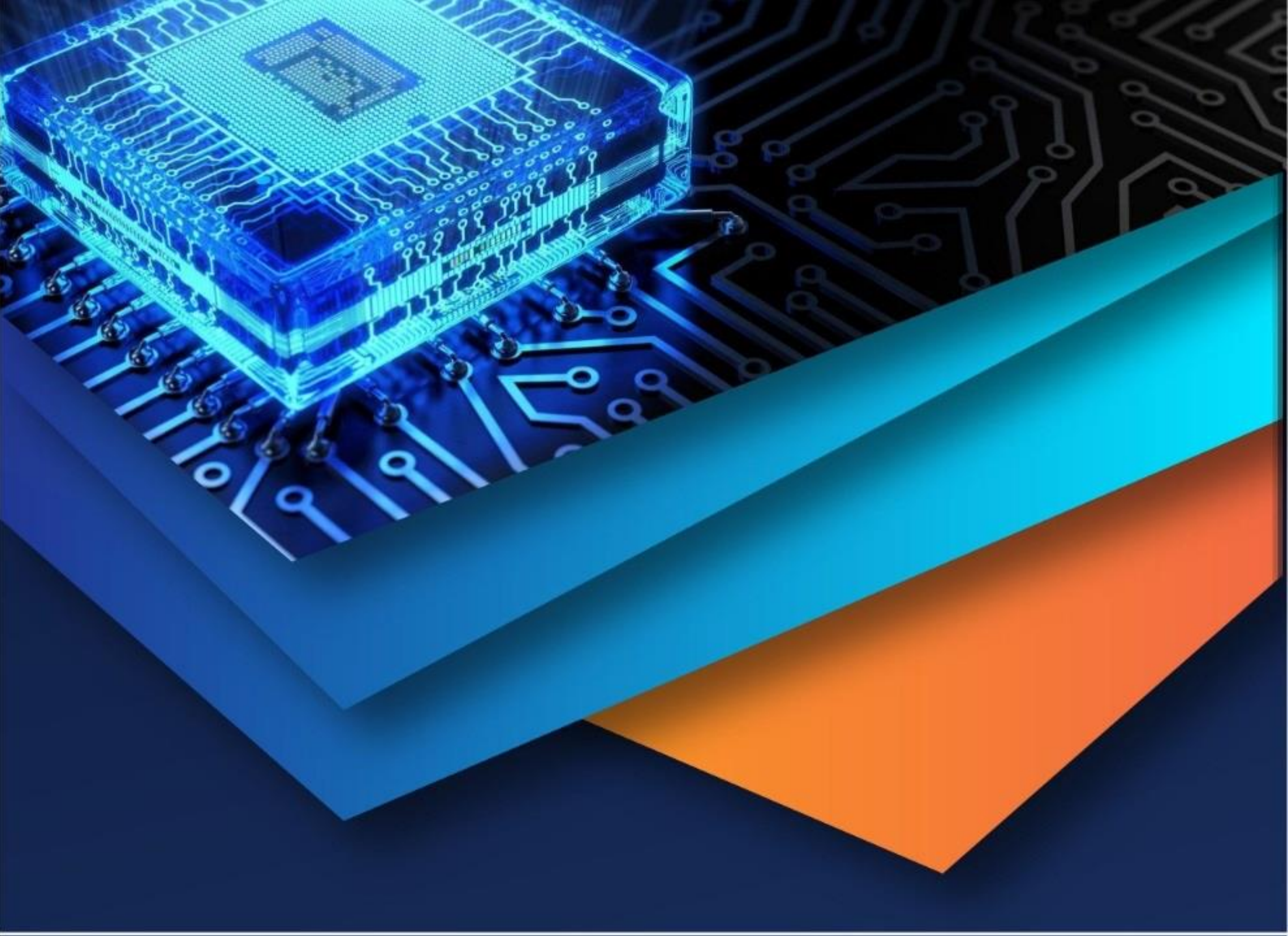
Cherif Rezgui et al.	2012	A PAPR reduction technique based on Golay sequences and Fractional Fourier Transform for OFDM Systems	Maintains low complexity	Decreases the efficiency of Golay coders and FRFT.
Rasmeet Kour, Dr. Amandeep Singh Sappal	2013	A Methodical Approach for the Construction of 64-QAM Golay Complementary Sequences Having Low Peak-To-Average Power Ratio	PAPR of 6.69 dB has been achieved.	The code can work only for 64-QAM signal

IV. CONCLUSIONS

In this paper, we have presented a review on PAPR reduction methods for OFDM signal. The work done by various researchers and scientists has been reviewed along with the strengths and limitations in their research work. We have enlighten the work done in this field which can be useful for developing new research ideas in the field of PAPR reduction for OFDM signal. Weaknesses and strengths are pointed in tabular form.

REFERENCES

[1] Prasad, R. (2004) OFDM for Wireless Communications Systems. Artech House Universal Personal Communications Series, Boston London.
[2] T. S. Rappaport, 'Wireless Communication: Principles and Practice': 2nd Edition, Prentice Hall, 2002.
[3] Aparna P. More et.al, "The reduction of PAPR in OFDM system using clipping and SLM method", IEEE , vol. 1, year 2011.
[4] Lim, D.W., Heo, S.J. and No, J.S. (2009) An Overview of Peak-to-Average Power Ratio Reduction Schemes for OFDM Signals. Journal of Communications and Networks, 11(3).
[5] Abdullah, Md. I., Mahmud, Md. Z., Hossain, Md. S., Islam, Md. N. (2011) Comparative Study of PAPR Reduction Techniques in OFDM. Asian Research Publishing Network Journal of Systems and Software, 1(8), 263-269.
[6] Sengar, S. (2012) Performance Improvement in OFDM system by PAPR reduction. Signal and Image Processing International Journal 3(2), 157-169.
[7] Yingzi, L. et al. (2003) Performance Analysis of PAPR in MC-CDMA Using Golay Code. Proceedings of 14thIEEE International Symposium on Persona1, Indoor and Mobile Radio Communication, 2, 1154-1158.
[8] Yang, L. and Alsusa, E. (2007) Novel Low-Complexity Post-IFFT PAPR Reduction Technique by Utilizing Amplitude Transforming for OFDM Systems. Proceedings of Wireless Communications and Networking Conference,IEEE Communications Society, 1339-1343
[9] Chen and Lian (2007) Construction of 16-QAM and 64-QAM OFDM Codes with Low PAPR and Large Euclidean Distance.*Institute of Electronics, Information and Communication Engineers*(IEICE) Transactions on Communication.
[10] Tigrek, R.F. and Genderen, P.V. (2007) A Golay Code Based Approach to Reduction of the PAPR and its Consequence for the Data Throughput. Proceedings of the 4th European Radar Conference, Munich Germany, 146-149.
[11] Urban, J. (2008) PAPR Reduction In OFDM Systems By Simplified Clipping And Filtering With Bounded Distortion.
[12] Kasiri, K. and Dehghani, M.J. (2009) A Blind SLM Scheme for Reduction of PAPR in OFDM Systems. World Academy of Science, Engineering and Technology, 26, 399-402.
[13] Bakhshi, H. et al, (2009) Peak-to-Average Power Ratio Reduction by combining Selective mapping and Golay complementary sequences. 5thInternational Conference, Wireless Communications, Networking and Mobile Computing, IEEE, 1-4.
[14] Huang, S.C.H., Wu, H.C. and Cioffi, J.M. (2010) Novel PMEPR Control Approach for 64- and 256-QAM Coded OFDM Systems. Proceedings of IEEE Globecom, 1-6.
[15] Mukunthan, P. (2011) Modified PTS with FECs for PAPR reduction in MIMO-OFDM system with different subcarriers. International Symposium on Humanities, Science and Engineering Research, IEEE, 89-94.
[16] Rezgui, C. et al, (2012) A PAPR reduction technique based on Golay sequences and Fractional Fourier Transform for OFDM Systems. Computing, Communications and Applications Conference, IEEE, 383-386.
[17] Rasmeet and Sappal (2013) Analytical survey on controlling Peak to Average Power Ratio by using 16-QAM Golay Complementary Sequences, International Journal of Innovative Research and Studies, Vol. 2,231-238.



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