ISSN(Online) : 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

A Review of Various Approaches for PAPR Reduction in OFDM System

Jaya Misra, Rakesh Mandal

Assistant Professor, Dept. of ETC, SSEC, (SSTC), Bhilai, Chhattisgarh, India

Assistant Professor, Dept. of ETC, SSGI, (SSTC), Bhilai, Chhattisgarh, India

ABSTRACT: Now a days Orthogonal Frequency Division Multiplexing (OFDM) has become as a popular communication technique in digital communication systems as it offers many advantages such us high bit rate, strong immunity to multipath fading , high spectral efficiency and easy equalization but it suffers with a high Peak-to-Average Power Ratio (PAPR) problem at the transmitted signal which should be minimized for efficient transmission. Currently, the PAPR problem is an active area of research and in this paper we present various techniques that helps in PAPR reduction.

KEYWORDS: Orthogonal Frequency Division Multiplexing (OFDM), Peak-to-Average Power Ratio (PAPR), multipath fading.

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) has become an efficient technology for wireless communications. It offers the considerable high data rate transmission, high spectral efficiency; immunity to the frequency selective fading channels, multipath delay spread tolerance, and easy equalization [1]. It is found to be very efficient in wireless local area networks (LAN) and WIMAX, digital audio broadcasting (DAB), digital video broadcasting (DVB) and also in 4G mobile communications.

Orthogonal Frequency Division Multiplexing is actually a Multi-Carrier Modulation technique where a single high rate data-stream is subdivided into multiple low rate data-streams and is then modulated using subcarriers.These subcarrierts are orthogonal to each other. Here we transmit the data in parallel, by using a large number of modulated sub-carriers.By doing this, we are dividing the available bandwidth and also they are sufficiently separated in frequency, so that they are orthogonal to each other. The Orthogonality of the carriers means that each carrier has an integer number of cycles over a symbol period. At the Receiver end the signal is demodulated and recombines to recover the Original message signal.

Since, multiple subcarriers are added in this technique to form the transmitted signal therefore OFDM suffers from Peak to Average Power Ratio (PAPR) value of the transmitted signals. Infact PAPR is the most disasterous effect of OFDM .Due to the high PAPR, the complexity of analog to digital (A/D) and digital to analog (D/A) converters increases, signal to noise ratio decreases and it also affects the efficiency of high power RF amplifiers.

Peak-to-average power ratio (PAPR) is directly proportional to the number of subcarriers used for OFDM systems. In other words Any OFDM system with more number of subcarriers will have a large PAPR as these subcarriers add up coherently which results in high peaks.

ISSN(Online) : 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

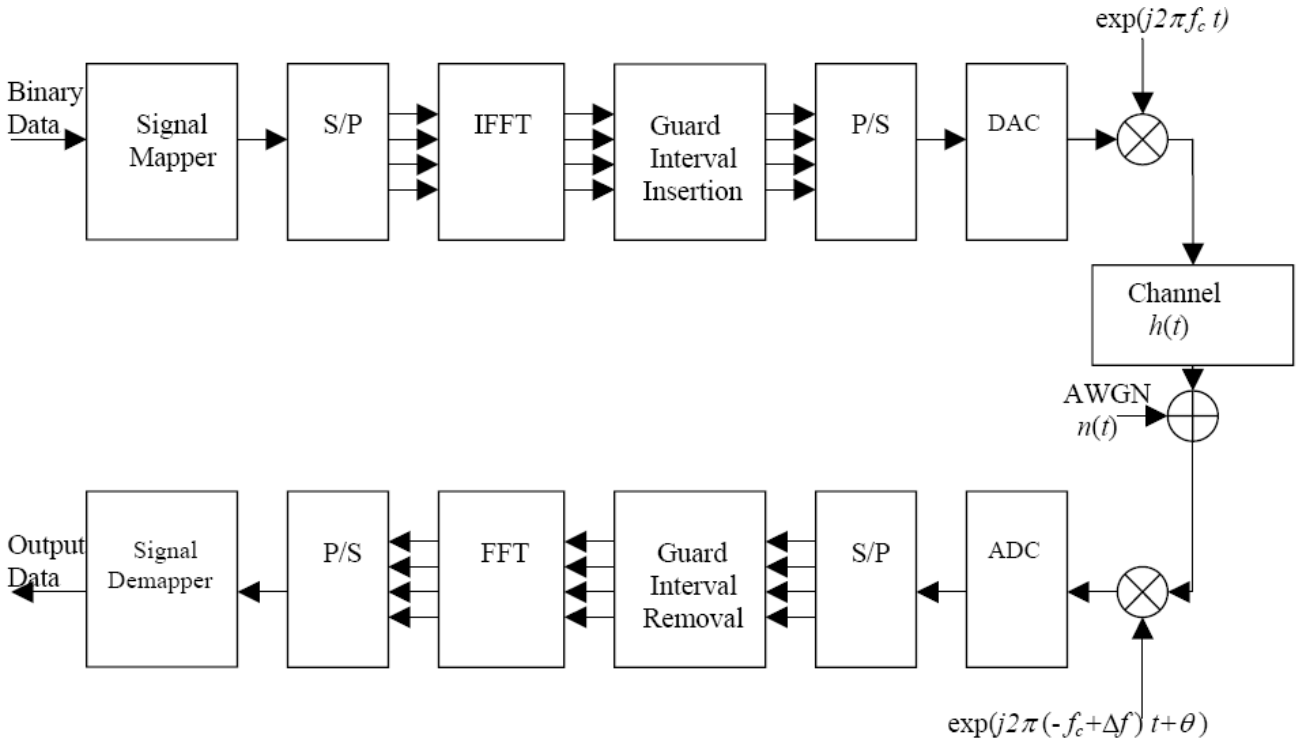

Fig: Basic Block Diagram of an OFDM System

II. PEAK TO AVERAGE POWER RATIO (PAPR)

Peak to-average power ratio (PAPR) is defined as the peak amplitude squared (which gives the peak *power*) divided by the root mean square (rms) value squared (which gives the average *power*). Or in other words,

$$PAPR = \frac{|x|_{\text{peak}}^2}{x_{\text{rms}}^2} = C^2.$$

Here C is the crest factor.

III.PAPR REDUCTION CRITERIA

Here ,In this section we are defining some criteria for the *Peak to Average Power Ratio* and Bit error rate reduction techniques.

There are various techniques and few hybrid techniques (in which two techniques from Individual techniques are combined together) are used for PAPR and BER reduction for acceptable results. For an efficient technique, the technique must reduce the PAPR and BER largely plus the following performance factors have to be considered for OFDM based system:

PAPR Reduction Capability
The primary factor of selecting any of the PAPR reduction technique is the capability of PAPR reduction. A technique is considered to be the best if it reduces PAPR largely. Out of band (OOB) radiation and In band (IB) distortion are few considerable factors for selecting a technique.

ISSN(Online) : 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

Low Average Power
A technique must not only reduce PAPR but it should also take care that the average power of the signal not gets increased from an acceptable region. Otherwise it will affect the operation of HPA, resulting in the increase in the BER rate of the OFDM system.

Low Complexity
The technique should also not increase the complexity as well as cost of the overall system. Complexity includes both processing time and hardware requirements for implementation of the system.

Less Bandwidth Expansion
Some techniques e.g. scrambling techniques needs side information in addition to main information, which increases the bandwidth requirement. Some coding techniques also increases the bandwidth due to code rate generation .The technique must not increase the bandwidth to value which causes degradation in the throughput.

BER Performance
The main goal of the PAPR reduction technique is to achieve better performance including BER as compared to conventional OFDM system.

Good Spectral Efficiency
If a technique increases the Inter Carrier Interference or immunity to multipath fading or some other advantage related to spectral efficiency then that technique should not be considered as a good PAPR reduction technique.
Thus we can conclude that PAPR reduction techniques vary in accordance with the system need and are dependent on many factors described above. One has to consider all the criteria before adopting any of the PAPR reduction technique of the system.

III. OVERVIEW OF PAPR REDUCTION TECHNIQUES

(1) **AMPLITUDE CLIPPING AND FILTERING:** In this technique, a threshold value of the amplitude is set and if any of the sub-carrier exceeds that set value then that value is clipped off or filtered to lower the PAPR.

(2) **SELECTED MAPPING (SLM)**: In this scheme, the transmitter transmits sufficiently large number of alternative data blocks, all data blocks represents the same information as the original data blocks. Then IFFT on these alternative data blocks is done .At the end, the one with the lowest PAPR is selected for transmission purpose [1].

(3) **PARTIAL TRANSMIT SEQUENCE (PTS):** In this technique, the input data block is first partitioned into different sub-blocks and then each sub-block is multiplied by different phase weighting factors. These phase weighting factors are obtained by optimization algorithm. These sub-blocks will have minimum PAPR, if they are phase shifted optimally and finally the PAPR value of the merged signal minimizes. The PAPR reduction depends on the number of sub-blocks and sub-block partion scheme [2].

(4) **TONE RESERVATION (TR):** In this scheme we use some small number of unused sub-carriers for Squared Crest Factor (SCF) control. These unused sub- carriers are known as Peak Reduction Carriers (PRCs) .These PRCs are orthogonal to the sub-carriers containing data, thus introduces no distortion. At the receiving end the PRC contents are ignored as it does not contains any significant information. This method does not need any side information to be transmitted with the transmitted signal but increases the bandwidth problem as it uses some unused carriers [3].

(5) **TONE INSERTION (TR):** The main idea used in this technique is to expand the constellation so that each point in the original constellation maps with several equivalent points in the expanded constellation .Due to extra mapping points used for PAPR minimization, the complexity of the system and signal power gets increased. Here no new sub-carriers are inserted rather some modulated sub-carriers are relocated from their original position to new positions. The two constellation points represent the same information [4].

ISSN(Online) : 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

(6) **COMPANDING:** In this technique, the dynamic range of the signal is reduced by compressing the high peaks and increasing the amplitude level of weak signal such that the signal peak does not exceed system limitations. At the receiving end, the compressed signal is then reconstructed by applying the reverse operation .Few companding techniques are: In μ-law companding, Exponential companding, Trapezoidal companding etc. Here, the reduction in PAPR is achieved at the cost of degraded BER. [5]

(7) **CODING TECHNIQUES:** The main idea used in any coding techniques is to reduce the PAPR simply by coding the data with a set of permissible code words neglecting the one which results in excessive peak envelope powers [6].The set of code words can be selected by many approaches. The various coding techniques used are Block coding Schemes, Sub block coding schemes, Block coding with error correction etc.

(8) **PRECODING TECHNIQUES:** Any of the precoding techniques reduces the PAPR by implementing the Precoding matrix [P] before the IFFT operation. The various precoding techniques used are The Discrete Hartley Transform (DHT) Precoding, The Discrete Fourier Transform (DFT) Precoding and The Discrete Cosine Transform (DCT) Precoding Techniques.
So, one should carefully choose the reduction technique according to the system requirement.

IV. CONCLUSION

Orthogonal frequency division multiplexing (OFDM) is a multicarrier modulation scheme, possessing several advantages like high spectral efficiency, immunity to ISI etc and can be used for both wired as well as wireless high rate digital data transmission purpose. Inspite of all these advantages one of the serious drawbacks, that OFDM suffers is high peak to average ratio(PAPR).The Different techniques proposed to diminish the high PAPR effect have been discussed in this paper. No PAPR technique have been proved to be the best solution .These techniques reduces the PAPR at the cost of BER degradation, increase in transmitted signal power, increase in system complexity, cost etc.

REFRENCES

1. R. W. Bauml, R. F. H. Fisher and J. B. Huber, "**Reducing the Peak-to-Average Power Ratio of Multicarrier Modulation by Selected Mapping**", Electronics Letters, vol. 32, no. 22, pp. 20562057, Oct. 1996.
2. P.Mukunthan and P.Dananjayan Department of Electronics and Communication Engineering Pondicherry University, Pondicherry Engineering College, Pondicherry-605 014 INDIA. "**A Modified PTS Combined with Interleaving and Pulse Shaping Method Based on PAPR Reduction for STBC MIMO-OFDM System"**
3. NandalaL.V, Kiruthika.V Electronics and Communication Engineering Anna University Sri Krishna College of Engineering and Technology, Coimbatore INDIA "**Power Reduction in OFDM systems using Tone Reservation with Customized Convex Optimization**"
4. J. Tellado, "**Peak to Average Power Reduction for Multicarrier Modulation**," Ph.D. dissertation, Stanford University, 2000.
5. Neeraj Sharma, "**Peak-to-Average Power Ratio Reduction Techniques for OFDM Signals"** International Journal of Computer Applications (0975 – 8887) Volume 96– No.22, June 2014
6. Wilkison, T.A. and Jones, A.E., **"Minimazation of the peak to mean envelope power ratio of multicarrier transmission schemes by block coding**", IEEE Vehicular Technology Conference, Vol.2., Jul 1995