

PAPR Reduction Techniques In OFDM: A Brief Review

Mr. Suraj Shete.
Electronics engineering Dept.
DKTE's TEI, Ichalkaranji.

Prof. R. N. Patil.
Electronics engineering Dept.
DKTE's TEI, Ichalkaranji.

Prof. P. M. Jadhav.
Electronics engineering Dept.
DKTE's TEI, Ichalkaranji.

Abstract: OFDM is multi-carrier communication technique which is used in both wired and wireless communication. OFDM is the time domain signal which is a sum of several sinusoids and these sinusoids makes Peak to Average Power Ratio (PAPR). This paper represents an overview of reduction of PAPR using all proposed techniques. According with performance according with application we can use appropriate technique.

KEYWORDS: OFDM, PAPR, SLM, PTS, WHT.

INTRODUCTION:

Communication is one of the important aspects of life. With the advancement in age and its growing demands, there has been rapid growth in the field of communications. Signals, which were initially sent in the analog domain, are being sent more and more in the digital domain these days. For better transmission, even single-carrier waves are being replaced by multi-carriers. Multi-carrier systems like CDMA and OFDM are now-a-days being implemented commonly. OFDM is multi-carrier communication technique which is used in both wired and wireless communication. In the OFDM system, orthogonally placed sub-carriers are used to carry the data from the transmitter end to the receiver end. Presence of guard band in this system deals with the problem of ISI and noise is minimized by large number of sub-carriers. OFDM sends many low speed transmissions simultaneously and hence it avoids the problem of Inter Symbol Interference (ISI). OFDM is the time domain signal which is a sum of several sinusoids and this sinusoids makes Peak to Average Power Ratio (PAPR). The high peaks usually drive the power amplifier into saturation, clipping the transmitted waveform and introducing in-band and interference affects the systems that operates at surrounding frequencies, out-band interference. The in-band interference reduces the system performance while out-band.

1. Papr:

OFDM is generated by first choosing the spectrum required, based on the input data and modulation scheme used. Each carrier to be produced is assigned some data to transmit. OFDM consists of lots of independent modulated sub-carriers. This leads to the problem of peak to average power ratio (PAPR). Then PAPR is defined as the ratio between the maximum instantaneous power and its average power during an OFDM symbol.

$$\text{PAPR} = \max [|x(t)|^2] / [E(A)]^2 \dots\dots\dots [1]$$

Where $\max [|x(t)|^2]$ is maximum or peak power and $[E(A)]^2$ is average power of transmitted symbol. To get proper values of PAPR oversampling is necessary. Oversampling can be performed by padding IFFT source data with zeros. So PAPR is major drawback of OFDM system so in this paper we represent some PAPR reduction techniques.

2. PAPR REDUCTION TECHNIQUES: FOR PAPR reduction individual as well as combined techniques are used. The effect of each technique is different.

1] **INDIVIDUAL TECHNIQUES:** To reduce the PAPR, several individual techniques have been proposed, which can be divided into three categories.

a) **SINGAL SCRAMBLING TECHNIQUES:**

1. Block coding techniques

Different code words are used in block coding technique. In this code words are transmitted along with original OFDM symbol, but for better result selection of proper code word are essential. In block coding technique no need to transmit side information and received signal can be easily decoded. Error correction can be done in this technique. But this method results in distortion.

2. Sub block coding

In sub Block coding large input frames are divided into small sub blocks. The $\frac{3}{4}$ code rate of total code is added to last odd parity checking bit. For large input stream this method is more efficient than Block coding technique.

3. Selective mapping (SLM)

In this method selection of optimal combination of phase factors with lower PAPR is carried out. In selective mapping side information is passed only with selected signal. That means in SLM only chosen signal is mapped.

4. Partial Transmit Sequence (PTS)

In PTS the whole sequence is divided into non-overlapping sub blocks. This sub blocks are assigned by independent rotation factor. This factor generates time domain data with lowest amplitude. This selection of lowest

amplitude gives results in reduction of PAPR. PTS gives better performance than SLM.

5. Adaptive Interleaving

In adaptive interleaving early threshold termination is established. So searching process is terminated when the value of PAPR reaches below the predefined threshold value. We can adapt the threshold value depending upon the application, so adaptation is done.

6. Tone Reservation

In tone reservation, reserved tones can be used to minimize the PAPR. When there are number of tones are small then there will be small PAPR reduction and vice-versa. In this method no need of decoding at the receiver end.

b) SIGNAL DISTORTION TECHNIQUES

1. Clipping and filtering

This is effective method for PAPR reduction in which initially clipping is done and then filtering is carried out. Since clipping is non-linear process which increase the band noise distortion, Bit Error Rate (BER) and decrease spectral efficiency. Filtering after clipping reduces out of band distortion. For PSK modulation this method is more effective.

2. Peak Windowing

In Peak Windowing technique different windows having large signal peaks like Cosine window, Kaiser window, Hamming window, Hanning window, Gaussian window etc. are multiply with original OFDM signal. The resultant spectrum is nothing but convolution of applied window and original OFDM signal. Depending upon the application we can use the standard window.

c) PRE-CODING TECHNIQUES

1. Modifying FFT and IFFT algorithms

This is pre-processing method for PAPR reduction. In this method slight modification is done in matrix coefficient of IFFT matrix at transmitter and FFT matrix at receiver. In this method two columns of IFFT matrix are replaced with their linear combination in order to reduce PAPR. These columns correspond to maximum and minimum value of OFDM signal. Also with the slight change in FFT matrix we get better PAPR reduction.

2. Golay complementary sequence

In Golay complementary sequence two sequences whose aperiodic autocorrelations sum becomes zero in all out-of-phase positions are used for PAPR reduction. These sequences are called Golay complementary sequences. These sequences are often defined over an alphabet of size 2 (binary), 4 (quaternary) or 8 (octary). In this, PAPR reduction is valid only for OFDM signals without guard frequencies. With guard frequencies the PAPR reduction is not so good.

3. Reed Muller code

Reed Muller code is efficient way for PAPR reduction. In this Reed Muller code is applied to given OFDM signal but bandwidth expansion and power loss occurs.

4. Walsh Hadamard Transform (WHT)

The Walsh Hadamard Transform (WHT) is a nonsinusoidal, orthogonal linear transform. WHT decomposes a signal into set of basic functions. These functions are Walsh functions, which are square waves with values of +1 or -1. The proposed hadamard transform scheme may reduce the occurrence of the high peaks comparing the original OFDM system. The idea to use the WHT is to reduce the autocorrelation of the input sequence to reduce the peak to average power problem and it requires no side information to be transmitted to the receiver. In Walsh Hadamard Transform (WHT) is more efficient way because in WHT no bandwidth expansion, no power increase, no data rate loss occurs. Also no Bit Error Rate (BER) degradation happens and it is distortion-less. Thus implementation of Walsh Hadamard Transform (WHT) pre-coding to reduce Peak to Average Power Ratio (PAPR) in conventional Orthogonal Frequency Division Multiplexing (OFDM) system is more effective than other techniques. WHT is becomes more effective when it is combined with other techniques.

2] COMBINED TECHNIQUES

A combined technique shows much better performance than individual techniques. Combined techniques are like as:

1. Joint companding transform with Hadamard transform
In this method Joint companding transform and Hadamard Transform both are used to reduce PAPR of OFDM signal. In this Hadamard Transform is applied before the IFFT and companding transform is applied after IFFT at the transmitting end while Inverse Companding Transform is applied before FFT and Inverse Hadamard Transform is applied after FFT at the receiver end. This method maintain good performance in BER as compared to ordinary companding techniques, also PAPR reduction performance is also improved.

2. Double WHT

In this method two times WHT applied to achieve better performance than WHT PAPR reduction technique. This method is more robust than WHT against nonlinearity. It have lower clipping probability than conventional OFDM.

3. DCT combined with SLM

In this method, DCT is combined with SLM using Riemann sequence. This is more effective than both individual PAPR reduction methods. If DCT is carried out before SLM then we can achieve 1.8 db PAPR reduction while if SLM is carried out before DCT then we get 1.2 db PAPR.

4. SLM combined with WHT and dummy sequenceinsertion

In this method, SLM is combined with WHT and dummy sequence is inserted into resultant signal. Better performance is achieved by this method.

CONCLUSION

Thus for PAPR reduction in OFDM different individual and combined methods are used. The effect of each method is different. Depending upon application or depending upon performance we can use appropriate method.

REFERENCES

1. Malhar Chauhan, Saurabh Patel, Hardik Patel, "Different techniques to reduce the PAPR in OFDM system" International Journal of Engineering Research and Applications (IJERA), year may-jun 2012, vol-2, issue-3, pp.1292-1294.
2. Zhongpeng Wang School of Information and Electronic Engineering, Zhejiang University of Science and Technology, Hangzhou, China Reduction PAPR of OFDM Signals by Combining SLM with DCT Transform
3. Keyvan Kasiri¹, Iraj Hosseini¹, Omid Taheri¹, Mohammad Javad Omid¹, P. Glenn Gulak² ¹Department, is Fahan University of Technology ²Department, University of Toronto "A preprocessing method for PAPR reduction in OFDM systems by modifying FFT and IFFT matrices"
4. Pepin Magnangana Zoko Goyoro, Ibrahim James Moumouni, Sroy Abouty "SLM Using Riemann Sequence Combined with DCT Transform for PAPR Reduction in OFDM Communication Systems"
5. A. Zolghadrasli and M. H. Ghamat, "An Overview of PAPR Reduction Techniques for Multicarrier Transmission and Propose of New Techniques for PAPR Reduction," Iranian Journal of Electrical and Computer Engineering, Vol. 7, No. 2, Summer-Fall 2008, pp. 115-120.

IJERT