# **Review On Competent PAPR Reduction Scheme In OFDM System**

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Abstract: One of the major disadvantages of OFDM is the high Peak – to – Average power ratio of OFDM signal. These multi – carrier systems have a problem that Peak – to – Average power ratio increases with the increase of number of subcarrier, which causes poor efficiency or serious performance degradation to transmit power amplifier. Many PAPR reduction techniques have been proposed. These techniques can be mainly categorized into signal scrambling techniques and signal distortion techniques. In this topic, there is study OFDM system and short view of different PAPR reducing techniques like Clipping, Companding, Peak Windowing, Scrambling, Coding and Selective Mapping (SLM).

Keywords: OFDM, PAPR, SLM, PTS, etc

# I. INTRODUCTION

High Bit Rate and reliable communication system demand led to have different modulation techniques. Technique is used Orthogonal Frequency Division Multiplexing (OFDM) is central in Wireless Communication system as it having High Data Rate and efficient to Multiple delay spread. OFDM has its significance for lead contain in Fourth Generation (4G) wireless services. OFDM system has enormous application in wired and wireless system, DAB-Digital Audio Broadcasting, (DVBT) Digital Video Broadcasting Terrestrial, Wireless PAN and LAN.OFDM signal consist of multiple sub-carriers, the system cause high Peak Power. One of major disadvantage of OFDM system is High Peak power to Average Power Ratio (PAPR), high PAPR causes waveform distortion due to nonlinear amplifier characteristics High PAPR can causes for Inter-modulation and Out of band radiation in transmission channel.

In this theme, we will study OFDM system and short view of different PAPR reducing techniques like Clipping, Peak Windowing, Scrambling, Coding and Selective Mapping (SLM).

# II. LITERATURE REVIEW

The proposed work described the PAPR reduction in OFDM system using various techniques suggesting the various development ways as illustrated in this part;

Shiragapur, Wali and Bidwai (2013) This paper explains operation and flow of execution for SLM Technique for PAPR reduction of OFDM signal.

Elavarasan, P.; Nagarajan G.; Narayanan, A., (2012) discussed the use OFDM system and PAPR reduction scheme which helpful to gain high data rate[2].

Yuya Inoue, Hiroshi Tsutsui, and Yoshikazu Miyanaga (2013) explained working principle of PTS scheme Bit-Error Rate improved using it[3].

YongSooCho and Jaekwon Kim, given introduction to OFDM system then basics of PAPR different PAPR reducing techniques like Clipping, Companding, Peak Windowing, Scrambling, Coding and Selective Mapping (SLM)[5].

Amit Ahlawat, is helpful to study Selective Mapping (SLM), Partial Transmit Sequence (PTS) and Tone Reservation (TR) and comparative study of PAPR reduction techniques. [7]

## III. PEAK-TO-AVERAGE POWER RATIO (PAPR)

*PEAK-TO-AVERAGE POWER RATIO (PAPR)* is defined as the large variation or ratio between the average signal power and the maximum or minimum signal power.

Theoretically, large peaks in OFDM system can be expressed as Peak-to-Average Power Ratio (PAPR) and it is usually defined as[1]:

$$PAPR = \frac{p_{Peak}}{p_{Average}} = 10 \log_{10} \frac{Max[|x_n|^2]}{E[|x_n|^2]} \dots \dots (1)$$

Where;

Ppeak represents peak power,

PAverage means average power.

E[.] denotes the expected value,

 $x_n$  represents the transmitted OFDM signals which are obtained by taking IFFT operation on modulated input symbols. Mathematical,  $x_n$  is expressed as:

$$x_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k W_N^{nk}$$
.....(2)

An OFDM system having N<sup>th</sup> sub-carriers and peak power of received signals is N times the average power when phase values are the same.

The baseband signal PAPR of will reach its theoretical maximum at[1]:

 $PAPR(dB) = 10\log(N)$  .....(3)

Another commonly used parameter is the Crest Factor (CF), which is defined as the ratio between maximum amplitude of OFDM signal and root-mean-square (RMS) of the waveform. The Crest Factor is defined as:

 $CF(x(t)) = \sqrt{PAPR} \dots (4)$ 

# **IV. PAPR REDUCTION TECHNIQUES**

Signal scrambling techniques work with side information which minimized the effective throughput since they commence redundancy. Signal distortion techniques introduce system complexity and band interference. Signal distortion methods reduces large peak by distorting signal before amplification [1].

- The signal distortion techniques are:
- Clipping and Filtering
- ✓ Peak windowing

PAPR reduction techniques have been detailed in the literature. These techniques are of two types. Such as signal scrambling techniques and signal distortion techniques.[1] The signal scrambling techniques are:

- ✓ Selective Level Mapping (SLM)
- Partial Transmit Sequences (PTS)

#### A. SIGNAL DISTORTION TECHNIQUES

## a. PEAK WINDOWING TECHNIQUE



Figure 1: Peak Windowing Technique.

Van Nee and Wild suggested peak windowing method. In this method it is possible to remove large peaks. Peak windowing reduces PAPRs as with respect to increasing the BER and out-of-band radiation. Clipping introduces PAPR reduction technique which is self interference

The Peak windowing offers better PAPR reduction with better properties of spectrum. Peak Windowing technique provides better PAPR reduction with compare to clipping. [5]

In peak windowing, multiplication of large signal peak with a specific window performed, for e.g.; Hamming window, Kaiser, Gaussian shaped, Cosine, etc.The output spectrum is a convolution of spectrum of the applied window with the original OFDM spectrum.

Hence, the window should have to be as narrow band as possible, in opposition the window not be too long in the time domain because various signal samples are affected, this resulting increase in bit error rate (BER).[6]

# b. CLIPPING AND FILTERING TECHNIQUE



Figure 2: Block diagram of Clipping and Filtering.

High PAPR is major problem in OFDM .High PAPR led to increased complexity of the ADC and DAC and in reduction efficiency of radio frequency (RF) of the power amplifier.

One of the easy and valuable PAPR reduction techniques is clipping, which helpful to remove the signal components that go beyond some fixed amplitude called clip level. Clipping is nonlinear process and causes noise distortion in band, which causes deprivation in the performance of out of band noise and BER bit error rate, which decreases the spectral efficiency. [7]

Clipping and filtering technique is useful in removing components of the expanded spectrum. Filtering can decrease the growth of spectrum, filtering after clipping can reduce the out of band radiation and resulting into peak re-growth, which the peak signals level up in the clip level. Out-of-band causes by performing interpolation before. To pass up this, signal should be clipped after interpolation. Significant peak regrowth is observed after this. Then, iterative clipping and frequency domain filtering used to avoid peak re-growth. [7]

Clipping operation is performed to cut high peak amplitudes and frequency domain filtering is used to reduce the out of band signal, but affecting peak re-growth. The filtering and clipping process is performed iteratively until the amplitude is set to the threshold value level to avoid the peak out-of band and peak re-growth, which is helpful in getting low peak power.

## B. SIGNAL SCRAMBLING TECHNIQUES

## a. SELECTED MAPPING (SLM) [1]

Selective Mapping (SLM) approaches have been proposed by Bauml. This method is used for minimization of peak to average transmit power of multicarrier transmission system with selected mapping. Complete set for contestant signal is generated suggesting the same information in selected mapping, and then relating to the most approving signal is selected as consider to PAPR and transmitted.





In the SLM, the input data structure is multiplied by random series and resultant series with the lowest PAPR is chosen for transmission. In the above figure  $x_1, x_2, \ldots, x_M$  are input data sequence with respect to  $r_1, r_2, \ldots, r_M$  random signals. To allow the receiver to recover the original data to the multiplying sequence can be sent as 'side information'. [1]



Figure 4: Flow of Selected Mapping Technique.

One of the efficient methods is SLM method for reducing the PAPR difficulty. The excellent side of selected mapping method is that it doesn't remove the peaks, and can handle any number of subcarriers. The disadvantage of this method is the overhead of side information that requires to be transmitted to the receiver of the system in order to recover information

# b. PARTIAL TRANSMIT SEQUENCE (PTS)

Partial Transmit Sequence (PTS) technique has been proposed by Muller and Hubber in 1997. The scheme is based on the phase shifting of sub-blocks of data and multiplication of data structure by random vectors.[8] This technique is bendy and valuable for OFDM system. The most important reason behind this technique is that the input data frame is divided into non-overlapping sub blocks and each sub block is phase shifted by a steady factor to reduce PAPR. [3]



Figure 4: Block diagram of PTS Scheme.

PTS is probabilistic method for reducing the PAPR problem. It can be thought that PTS method is a adapted method of SLM. PTS method performs better than Selective Mapping method. The main benefit of this method is that when differential modulation is applied in all sub blocks then there is no need to send any side information to the receiver of the system,.[7]



Figure 6: Flow of Partial Transmit Sequence.

### V. OVERALL ANALYSIS OF DIFFERENT TECHNIQUES

There are techniques has been overviewed in literature. Thus, it is probable to decrease the large PAPR by using the dissimilar techniques. PAPR reduction technique should be selected with responsiveness according to various system requirements. [7]

	of	Name of parameters			
Name Schemes		Distortion less	Power increases	Data rate loss	
Clipping and Filtering		No	No	No	

Selective Mapping (SLM)	Yes	No	Yes
Partial Transmit Sequence (PTS)	Yes	No	Yes

Table 1: Study of different PAPR reduction scheme

#### VI. CONCLUSIONS

OFDM is a gifted technique in wireless communication systems although it has some drawbacks which are given below:

- ✓ High PAPR
- ✓ Frequency offset

High PAPR is one of the major problems of OFDM system. Every PAPR reduction techniques having advantages and disadvantages. These PAPR reduction techniques should be chosen carefully for getting the desirable minimum PAPR.

PAPR reduction techniques are depending on situation of system. This paper describes and summarizes techniques of PAPR and proposes repeated clipping and frequency domain filtering technique which is the best solution for PAPR. But most of them cannot achieve simultaneously a large reduction in PAPR with advantages like low complexity, good error correction and high frequency efficiency. Selective Mapping (SLM) is one of efficient and low complex method [9].

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