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PAPR Reduction in OFDM System using Clipping and Filtering based new Hybrid VLM Pre-Coded SLM

Muneeb Manzoor Bhat[1], Preeti Sondhi[2]

[1]M.Tech Scholar, Universal Group of Institutions Lalru, Punjab, India
mnbmnzr[at]gmail.com

[2]Assistant Professor, Universal Group of Institutions Lalru,Punjab,India.
Preetisondhi4@gmail.com

Abstract: ***One of the latest communications technologies is wireless networking. If it uses a given frequency range for transmitting huge amounts of data, the communication system is called effective. This provides efficient data transfer and an increasing 4G to 5G communications system. The OFDM system theory notes that it is a type of multi-carrier modulation of Orthogonal Frequency Division Multiplexing (OFDM) that has a large demand for digital wideband communication. It encodes the data at different frequencies of the carrier. Digital audio and high definition television, broadband networks and 4G mobile communications are included in these areas of use. It is widely used for communication purposes to reduce inter-symbol interference, decreased nonlinear distortion due to its great advantages as it provides high spectral efficiency. The OFDM system suffers from the inconvenience of high PAPR, i.e. Peak to average power ratio. In this paper, clipping and filtering based new hybrid VLM pre-coded SLM technique was proposed to minimize PAPR in OFDM. And it was found that the proposed scheme achieved a significant gain in reducing PAPR without increasing the process complexity and impacting the system's error output.***

Keywords: PAPR, OFDM, Iterative Clipping and Filtering, SLM, VLM, DCT

1. Introduction

Multiplexing of orthogonal frequency division (OFDM) is a multi-carrier multiplexing access scheme for the transmission of large data by the carrier. Future mobile generation networks are expected to deliver high data rates to fulfil future requirements for multimedia applications. The data rate needed for the 4 G network is 10-20Mbps, and in moving vehicles, OFDM is at least 2Mbps. PAPR is one of the disadvantages of the OFDM process (peak to average power ratio). In order to transmit information, this PAPR needs to be reduced. Several different methods are used to decrease the PAPR of the OFDM system. This paper addresses different methods that can be used in the OFDM process to minimise PAPR.

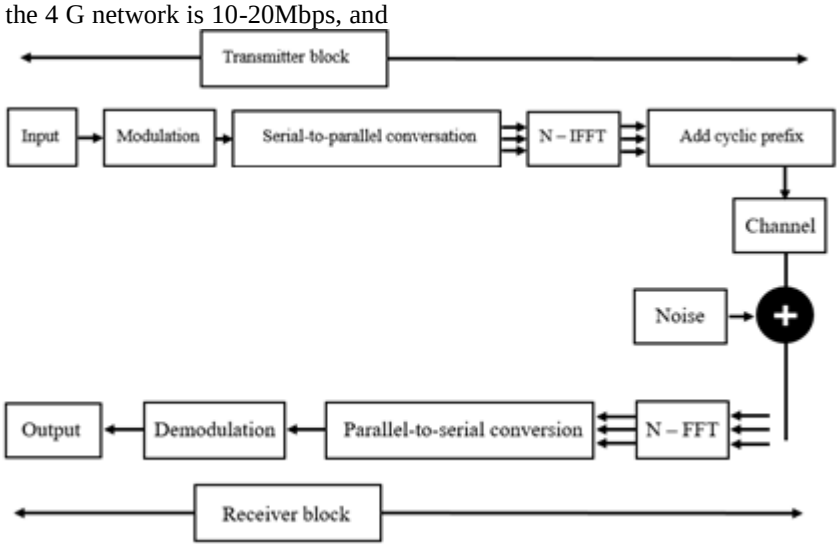


Figure 1: Block diagram of OFDM system

1.1 PAPR Problem & Requirement of Reduction

The OFDM system is a very powerful modulation scheme for wireless communication, but one of the key disadvantages of the high PAPR (peak-to-average power ratio) OFDM. PAPR is a predictably sinusoidal lead that is an essential point in the OFDM phase during OFDM transition to PAPR reduction. Because when dealing with real-life high-speed data communication such as high-speed internet access, digital audio broadcasting (DAB) and video

calling, terrestrial microwave television, digital video broadcasting (DVB), 4 G network, hyper LAN. So, as if we were seeing most of the communication networks, high volumes of data were expected. But in real life, these types of facilities are prohibited by high PAPR in the OFDM scheme. PAPR must therefore be reduced in the OFDM framework.

$$0 \le t \le NT \quad (1)$$

PAPR is defined as:

$$PAPR = \frac{\max|x(t)|^2}{E\left[|x(t)|^2\right]} \quad (2)$$

where E[.] denotes the expectation operator.

$$PAPR = \frac{\max|x(t)|^2}{E\left[|x(t)|^2\right]} \quad (3)$$

1.2 PAPR Reduction Techniques

1.2.1 Selected mapping (SLM)

A single OFDM sequence D with a length of N, divided into a number of sequences representing equal information with some rotation factors and thus transmitting the sequence with the lowest PAPR. If U is the number of new generated sequences called the SLM length, all these sequences are the product of multiplying different rotation factors in the incoming original OFDM sequence D by SLM length U. The quality of the SLM method depends on the length of the SLM U and the amount of scrambling done by these rotation factors. When we increase the number of SLM sequences but at the cost of that process complexity, PAPR performance will improve. Although there is moderate level of implementation complexity in the SLM technique this complexity increases as the length of SLM U increases.

1.2.2 Partial transmit sequence (PTS)

One of the techniques that would like to scale back PAPR in the OFDM process is the Partial Transmit Series (PTS). The basic PTS strategy is to separate information frames into non-overlapping freelance rotation problem sub-blocks. Time domain information with the lowest amplitude is generated for the exploitation rotation problem. Partial transmission sequence is that the adjusted SLM methodology offers improved performance compared to SLM.

1.2.3 Tone Reservation (TR)

In this method, an approximate signal must be added to the original signal so that the original signal PAPR can be reduced. The specifications of this technique are the original signal, and both should lie in disjoint frequency subspaces as the estimated signal. In the original signal, some tones are reserved to reduce the signal peaks. The reserved tone does not contain data, but it is difficult to generate approximate signal because it includes frequency domain data symbols. A corresponding frequency domain signal is therefore generated and the equivalent time domain signal is obtained in the frequency domain signal by taking IFFT of the above sum.

1.2.4 Tone Injection (TI)

Methodology for Tone Injection (TI) was proposed by Muller, S.H., and Huber, J.B. This method is based on the general PAPR reduction additive approach. The related technique of the exploitation degree additive achieves PAPR reduction of the multi-carrier signal with a loss of none frequency. For imaginative constellation points, TI uses a group of equivalent constellation points to cut PAPR back. The most important plan for this methodology is to extend the size of the constellation. That function within the original basic constellation will then be mapped into many equivalent points within the extended constellation, as all information pieces will be mapped into many equivalent constellation points. These new amounts of liberty should be used to reduce PAPR. The drawbacks of this method are; should look at the receiver part of the deciphering signal and trigger a lot of advanced IFFT operation.

1.2.5 Interleaving

During this adaptive strategy, the performance is reduced jointly in this exceptionally linked information system. Adaptive interleaving is to see early termination of the associate. The look-out approach is therefore terminated once the value of PAPR is less than the threshold value. Therefore, these low thresholds pressure the AIL to scan for all sequence interleaving. The value of interleaving is a larger or lesser amount compared to PTS.

1.3 Analysis of Different PAPR Reduction Techniques

Table 1.3: Analysis of Different PAPR Reduction Techniques

Sr. No.	*PAPR Reduction Techniques*	*Parameters*
1.	Selective Mapping Technique	• It decreases distortion. • There is no Power raise in SLM technique. • Selects the signal with lowest PAPR value for transmission.
2.	Partial Transmit Sequence	• This technique helps in reducing distortion. • No power raises. • It is complex in nature.
3.	Tone Reservation	• Reduces distortion effect. • Power gets raised in this technique. • It is less complex in nature.
4.	Tone Injection	• It reduces distortion effect. • Power raise is observed in this technique. • PAPR reduction is observed without data rate loss.
5.	Clipping & Filtering	• It introduces distortion. • No Power Raise. • It is one of the simplest techniques to apply.

2. Proposed Work

In this paper clipping and filtering based new hybrid VLM pre-coded SLM technique was proposed to minimize PAPR in MIMO-OFDM. The approach proposed is made up of two

methods, i.e. VLM pre-coded SLM method and iterative clipping & filtering PAPR reduction technique. It was found that a significant reduction in PAPR was accomplished by the proposed scheme without increasing the process complexity and impacting the system's error efficiency. The other advantage of the proposed method is the reduction of the measurement time.

3. Simulation & Results

In OFDM systems, pre-coded SLM techniques were applied to the OFDM signals to reduce the value of PAPR, DCT, Hadamard Transform and VLM, and the effects are compared with the actual OFDM. Iterative Clipping & Filtering technique is combined with VLM pre-coded SLM technique in order to further reduce the value of PAPR.

3.1 Clipping & Filtering

Clipping & Filtering in OFDM systems is one of the best ways to reduce PAPR value Clipping high peaks in OFDM signal is achieved in this process before it is passed through the power amplifier. I use this approach a clipper that restricts the envelope of the signal to the predetermined point. This level is regarded as the rate of clipping. If the signal goes beyond the point of the clipping, the clipper will only function. Otherwise, without any modifications, it passes the signal. The signal can be changed as:

$$y[n] = \begin{cases} -CL, & if\ x[n] \le -CL \\ x[n], & if\ -CL \le x[n] \le CL \\ CL, & if x[n] > CL \end{cases} \quad (4)$$

The relationship between the clipping ratio (CR) and the clipping rate:

$$CR = 20\log_{10}\left(\frac{CL}{E[X[n]]}\right) \quad (5)$$

Where CL is the level of clipping and where E[X[n]] is the OFDM signal average.

3.2 CCDF

The Complementary CDF (CCDF) is used instead of CDF, which lets us calculate the probability of reaching the specified threshold by the PAPR of a certain data frame. The CDF of signal sample amplitude is given by.

$$Fz = 1 - \exp z \quad (6)$$

The CCDF of the PAPR of the data block is desired is our case to compare outputs of various reduction techniques. This is given by

$$P\ (PAPR)>Z = 1 - P\ (PAPR \le Z)$$
$$= 1 - (Z)$$
$$= 1 - (1 - \exp[f_0]\ (Z))^N \quad (7)$$

3.3 PAPR

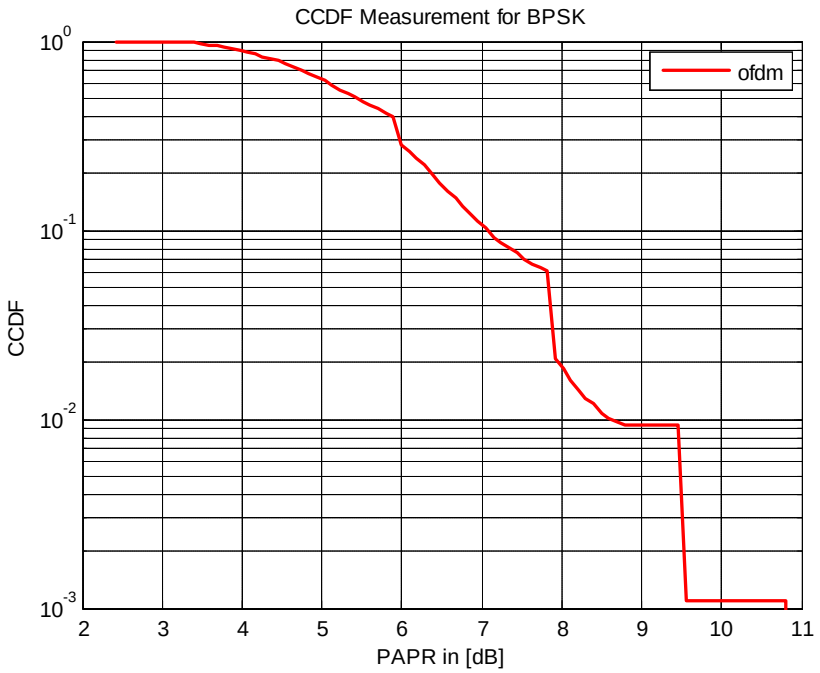
The transmitted OFDM signal consists of N number of independently modulated subcarriers that can produce a wide PAPR when continuously applied to the entire system. PAPR is defined as the ratio of maximum power to the modulated signal's average power. When a large number of signals are added together as N of the same stage, a large PAPR is generated. It is possible to determine the PAPR from the OFDM signal:

$$PAPR = \frac{\max_{0 \le t \le NT} |x(t)|^2}{1/NT \int_0^{NT} |x(t)|^2} \quad (8)$$

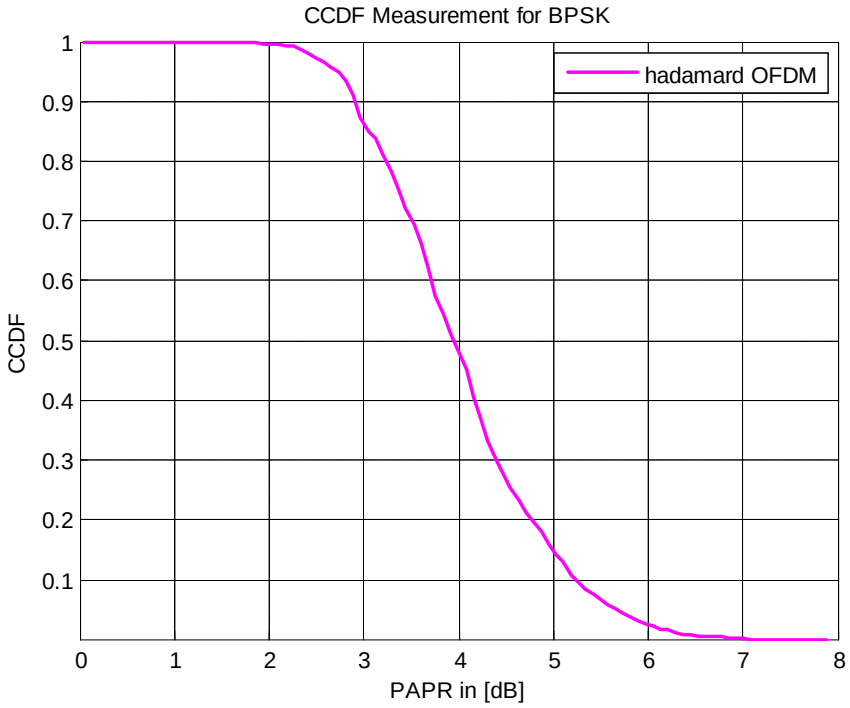
PAPR is given as a baseband OFDM signal with N number of sub channels:

$$PAPR = 10\log_{10}N \quad (9)$$

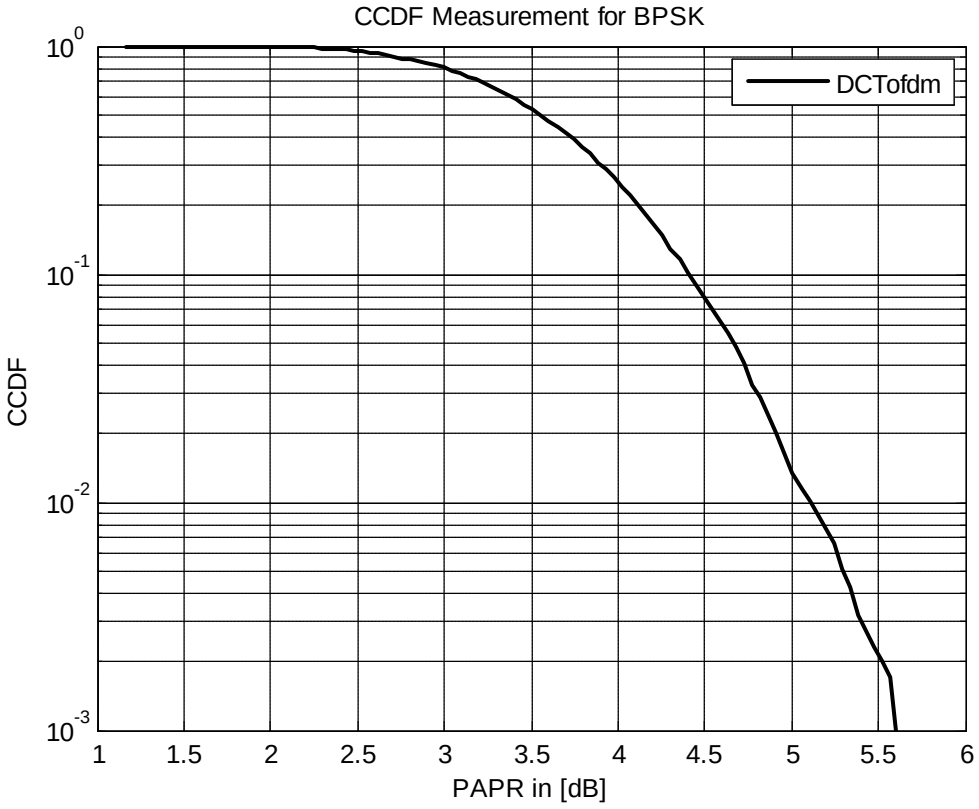
3.4 Performance Analysis



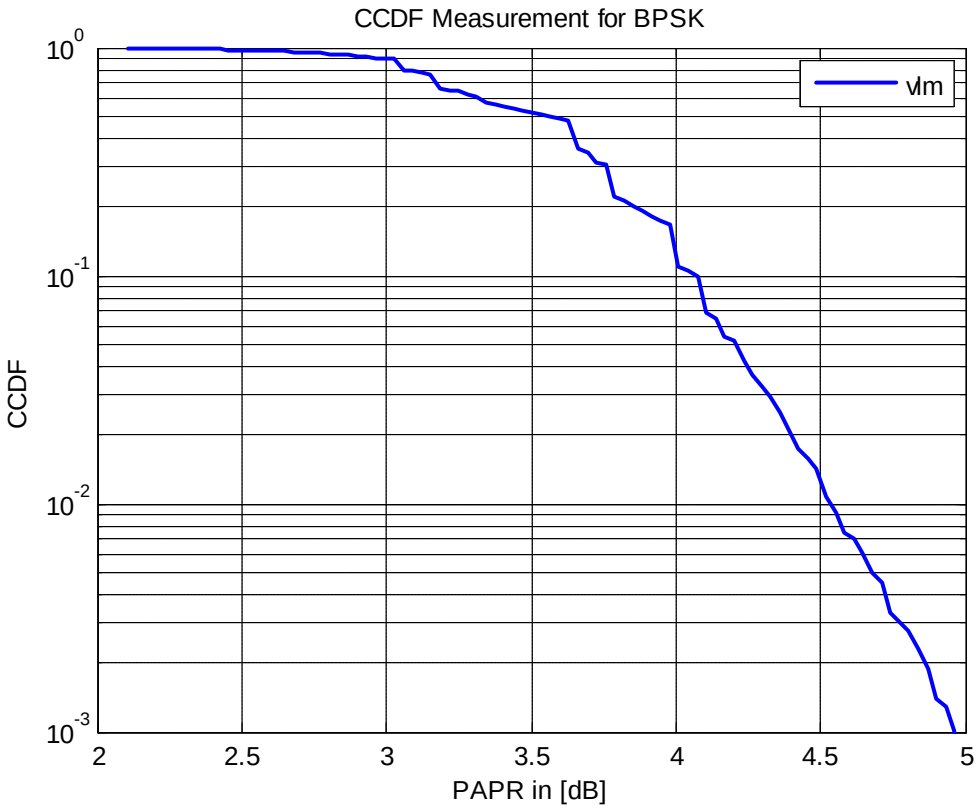
It can be seen from the above diagram that the PAPR value in the original OFDM signal is greater than 10 dB.



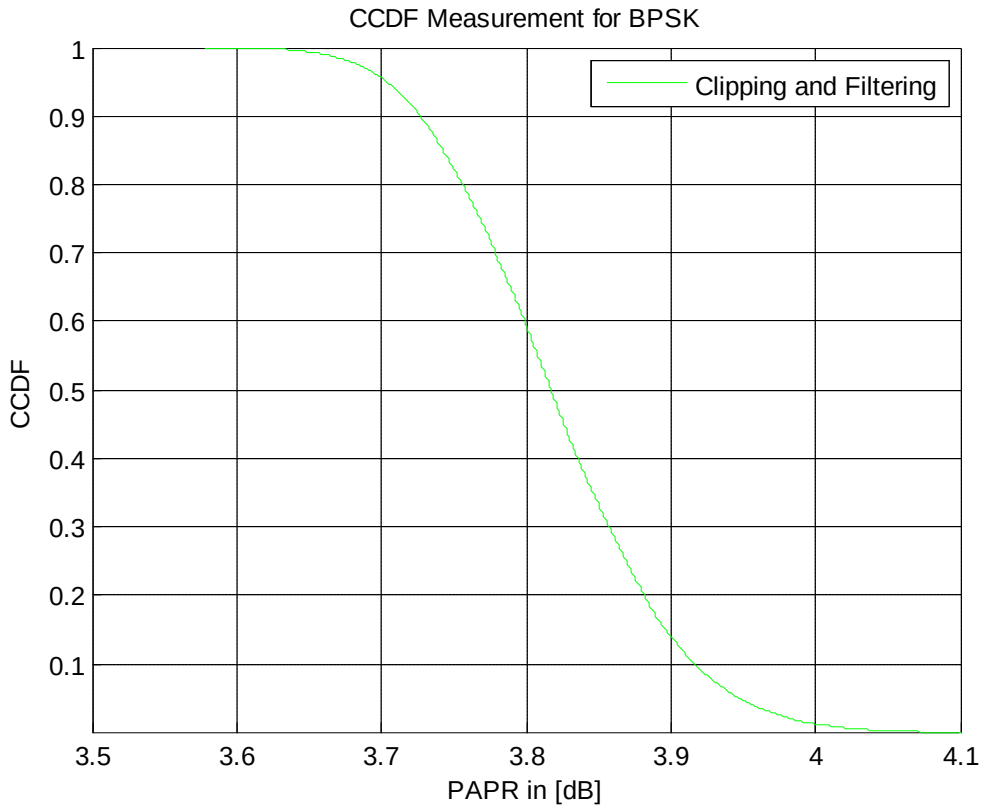
The above graphs in the Hadamard Transform OFDM signal give the value of PAPR is 7.50 dB.



The diagram above shows that in Discrete Cosine Trans-form OFDM the value of PAPR is 5.61dB.



The diagram above shows that in VLM Pre-coded SLM the value of PAPR is 4.9 dB.



The chart above shows that in VLM Pre-coded SLM with clipping and filtering the value of PAPR is 4.1dB

4. Conclusion and Future Work

In this article, a technique for PAPR reduction, i.e. The VLM pre-coded SLM scheme incorporates Clipping & Filtering. It is observed, after the simulation of the hybrid system that the value of PAPR has decreased to some degree. By clipping of the excessive high peaks and then filtering them from the pass band, the PAPR has been reduced. Without raising the device complexity, this hybrid scheme has given a successful PAPR reduction. This

concludes that scrambling techniques provide good performance, but to recover original data block it requires side details for the receiver, it also increases complexity. With no need for side details, pre-coding based techniques perform well and work with less complexity. For PAPR reduction, hybrid pre-coding plus scrambling technique gives the best performance. In future work, depending on the peaks in the field, I will try dynamic threshold value and estimate PAPR for the minimum bit error rate (BER) and the maximum data can be transferred.

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