**IOSR Journal of Engineering (IOSRJEN)** **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 09, Issue 6 (June. 2019), ||S (IV) || PP 57-62

# Performancce Analysis of PAPR Reduction in DWT-OFDM in comparsion with conventional OFDM System

Rayani Sunil[1]M Srinivasa Rao[2]
[1]*PG Scholar,Dept. of ECE,QIS College of Engineering and Technology,Ongole,India*
[2]*Assistant Professor,QIS College of Engineering and Technology,Ongole,India*

**Abstract:**Orthogonal frequency division multiplexing (OFDM) is an operative multicarrier wireless system for high transmission data rate and is widely used in wireless communication systems. In general, we use a conventional fast Fourier transform (FFT) OFDM for high transmission data rate. In present days, multi-carrier wireless systems suggest that the use of wavelet transforms (WT) outperforms the conventional fast Fourier transform (FFT) orthogonal frequency division multiplexing (OFDM) systems. Wavelets based systems provide better spectral efficiency because of no cyclic prefix requirement, have very narrow side lobes and also exhibit improved BER performance. However, the OFDM system suffers from a major drawback at the transmitter that is the high peak-to-average power ratio (PAPR) of the transmitted OFDM signal. Selected mapping (SLM) technique is used to achieve a good PAPR reduction without signal distortion. In this paper, an efficient PAPR reduction technique using SLM Wavelet-OFDM (SLM-WOFDM) is proposed. The simulation results show that the proposed system provides better PAPR reduction compared to the conventional SLM-OFDM and SLM-WOFDM systems.

**Keywords:** FFT, OFDM, PAPR, SLM, WOFDM, WT.

---

Date of Submission: 22-06-2019 Date of acceptance: 10-07-2019

---

## I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) technology is a key technique for achieving high data capacity and spectral efficiency requirements in the present, as well as in the future broadband wireless communication systems. OFDM is capable of combating intersymbol interference (ISI) by translating broadband frequency selective channel into a number of parallel narrowband channels. However, OFDM signal exhibits a high Peak-to-Average Power Ratio (PAPR), since the OFDM signal is the superposition of a large number of modulated subcarrier signals. From the last few decades, several authors proposed various PAPR reduction techniques. In this section, we address the few most prominent PAPR reduction approaches.Ochiai and Imai [1] performed digital clipping on the OFDM signals sampled at the Nyquist rate. In this technique, PAPR reduction is not significant enough and provides out of band radiation. Hence, to achieve the additional PAPR reduction, he combined selected mapping and clipping technique as a new technique.

Wang et al [2] proposed an A-law companding technique to reduce PAPR with low complexity. In this method, the PAPR of OFDM signals is reduced by increasing the average power of signals while keeping the peak unchanged, but this reduction in PAPR may be very limited under certain BER performance constraints.Huang et al [3] investigated the performance of four typical companding schemes, namely, linear symmetric transforms, linear nonsymmetric transforms, non-linear symmetric transforms and non-linear nonsymmetric transforms. These methods alleviate the aforementioned problems in digital clipping. Specifically, compared with the clipping-filtering method, linear non-symmetric transforms may improve SNR significantly.

In PAPR reduction based on modified PTS with interleaving [4] discusses the PTS technique that is more advantageous in terms of PAPR reduction with higher complexity in terms of its implementation compared to conventional PTS [5] algorithm. In the novel sub-block, partitioning scheme [6] discusses the various sub-block partitioning techniques used in the PTS technique.

The main idea behind PAPR reduction in OFDM can be understood as reallocation of the peak power over all the antennas in use [7-10]. The main work in the proposed idea is the PAPR reduction using an SLM Wavelet-OFDM (SLM-WOFDM).

## II. OFDM SYSTEMS

### A) FFT- OFDM System

The schematic diagram of an OFDM system is shown in Figure 1. Firstly the transmitter converts the input data from a serial stream to parallel sets. Based on the constellation size, these parallel data are further mapped into corresponding symbols using a signal mapper. And then an inverse Fourier transform converts the frequency domain symbols into samples of the corresponding time domain representation of these symbols. Since inverse fast Fourier transform (IFFT) generates samples of a waveform with frequency components satisfying orthogonality conditions, it is used as an OFDM modulator. Next, the time domain signals are transmitted through the channel. The receiver receives the time domain signal and performs a fast Fourier transform (FFT) operation to obtain the corresponding frequency domain components. The magnitudes of these frequency components correspond to the original data. Finally, the parallel to serial block converts this parallel data into a serial stream to recover the original input data.

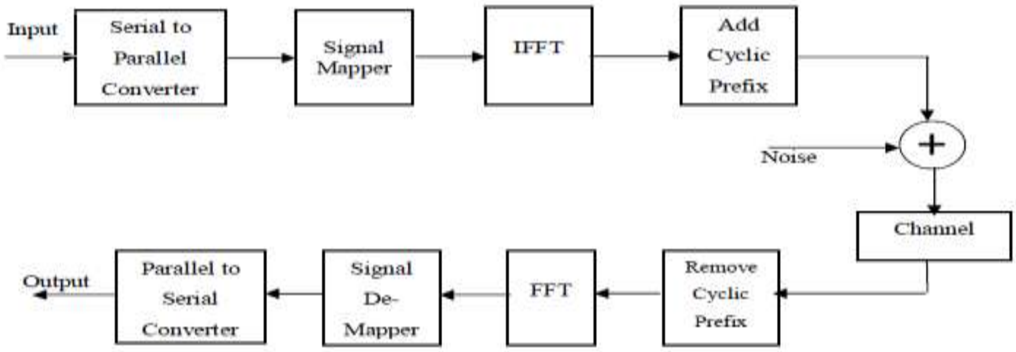


**Figure 1:** Schematic diagram of an OFDM system

### B) DWT-OFDM System:

Figure 2 shows the schematic diagram of the DWT based OFDM transmitter. Here, the high input data stream is converted to the low parallel data stream by using the serial to parallel conversion and it is transposed then it is passed through the low pass and the high pass then finally the output of it is the OFDM symbol which has to be transmitted over the AWGN channel.

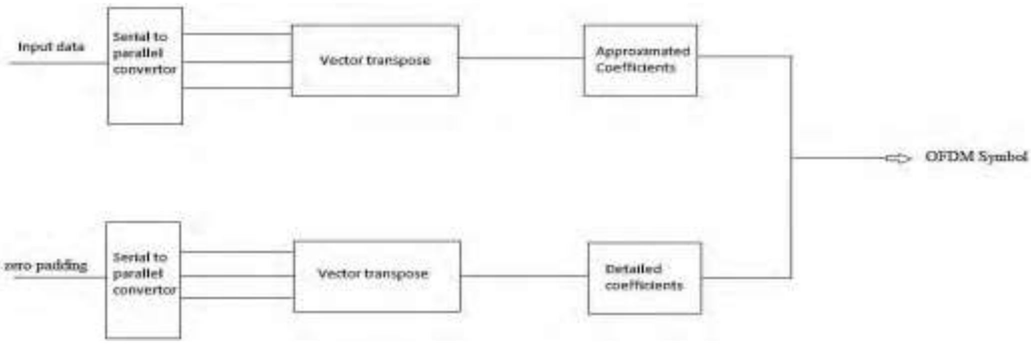


**Figure 2.**DWT Transmitter

Generally, zero padding in the time domain increases the number of samples whereas zero padding in the frequency domain results in an increased sampling rate in the time domain. In DWT Transmitter zero padding is done and at the receiver, zero is discarded. Figure 2 shows the schematic diagram of the DWT based OFDM receiver.

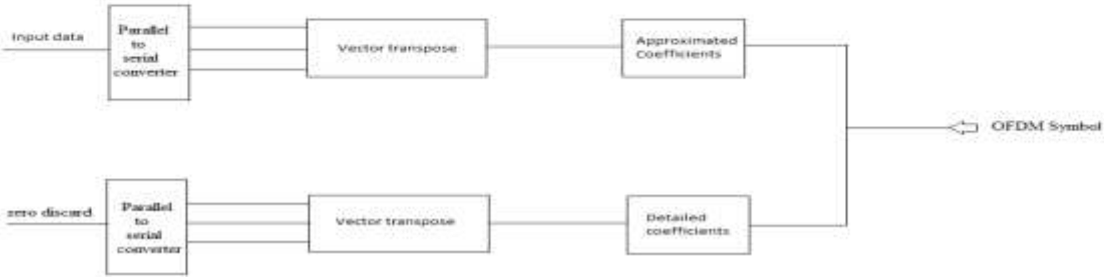


**Figure 3:**DWT Receiver

## III. PAPR REDUCTION USING SLM TECHNIQUE

The SLM technique is a simple and undistorted processing way to reduce the PAPR of OFDM signals [11]. The basic principle of SLM is to generate different versions of the same OFDM symbol and transmit the one with the lowest value of PAPR. To create these different versions of the same OFDM symbol, we consider *U* codes of length *M* and these codes are such that the initial constellation remains unchanged. If Cm [m=0, 1, 2, 3…..M-1] *K* is a point of 2^2k-QAM constellation, the randomly generated codes dm(m,u)=[0,1,2.....M-1]X[1,2,3,....U].

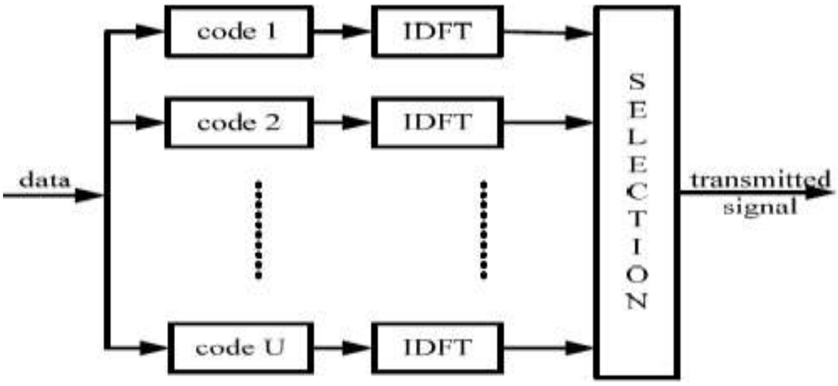


**Figure 4:** SLM scheme for PAPR reduction in OFDM Systems

In order to retrieve the original data, the receiver requires a perfect knowledge of the used code. Therefore log2U bits are needed to be transmitted as side information to recover them perfectly, leading to reduction of the useful data rate. By partitioning a wideband fading channel into flat narrowband channels, OFDM is able to mitigate the detrimental effects of multipath fading using a simple one-tap equalizer. However, in the time domain OFDM signals suffer from large envelope variations, which are often characterized by the peak-to-average ratio (PAR). High PAR signals, like OFDM, require that transmission amplifiers operate at very low power efficiencies to avoid clipping. In this thesis we review the most popular OFDM PAR-reduction techniques and demonstrate that selected mapping (SLM) is a particularly promising reduction technique. In a SLM system, an OFDM symbol is mapped to a set of quasi-independent equivalent symbols and then the lowest-PAR symbol is selected for transmission. The trade-off for PAR reduction in SLM is computational complexity as each mapping requires an additional inverse fast Fourier transform (IFFT) operation in the transmitter. In additional to an overview of current SLM work, we present a thorough analysis of SLM as well as several novel SLM proposals. First, we derive the closed-form expression for the expected PAR in an SLM system.

$$P(PAPR\ low<Z)=(P(PAPR>Z)M=1-(exp(-Z)N)M$$

The expected PAR can be thought of as a metric of PAR reduction capability. Second, we provide a power analysis of SLM to determine if the computational power costs outweigh the power saved through PAR reduction. Through this analysis, we show that SLM is capable of several Watts of net power savings when used in a wireless transmission system. Third, we propose that a PAR threshold should be set in SLM. Such thresholding leads to significant complexity decreases. Fourth, we derive the maximum likelihood (ML) and maximum exit {a posteriori} (MAP) detection metrics for blind SLM (BSLM) and threshold BSLM respectively. Lastly, we demonstrate that by using monomial phase sequences in SLM blind phase sequence detection is possible with a single FFT operation in the receiver.

## IV. PROPOSED SLM-WOFDM SYSTEM

In this paper, the SLM-WOFDM system was proposed seeking for an improvement in PAPR performance compared to the conventional SLM-OFDM. Figure 5 shows a block diagram of the conventional OFDM and Wavelet-OFDM using SLM technique.

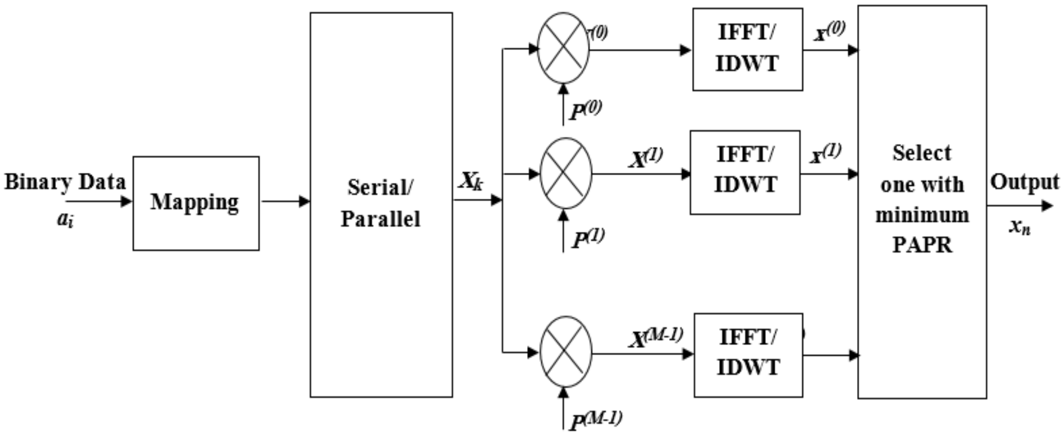


**Figure 5:** WOFDM transmitter block diagram using SLM.

In WOFDM System, the wavelet transform performs the multicarrier modulation at the transmitter and demodulation at the receiver as done by the Fourier transform in OFDM system. The wavelet transform is used to provide localization in time and frequency of the information, which is based on different basis functions of low-pass and high-pass transformation. This transform uses two sets of functions namely scaling and wavelet functions. The original signal *xn* is decomposed through a half-band low-pass filter *g*[*n*] and a by half-band high-pass filter *h*[*n*]. The signal is then downsampled by two since half the signal frequencies have been removed, half of the samples can be discarded according to Nyquist's theory. The decomposition can be expressed as following

$$y_{low}[k] = \sum_{n} x[n] g[2k-n]$$

$$y_{high}[k] = \sum x[n] h[2k-n]$$

Where *ylow*[*k*] and *yhigh*[*k*] are the output of high-pass and lowpass filters down-sampled by a factor of two. Reconstruction process is repeated by a series of high-pass and low-pass filters to obtain an orthogonal wavelet sequence. The overlapping nature of wavelet properties preserves the orthogonality of the output signal at the transmitter. Hence, WOFDM does not need cyclic prefix to fix the channel delay spread, thus improves the bandwidth efficiency .

## V. SIMULATION RESULTS

The parameters used in simulations are given in Table.1. The value of PAPR obtained using SLM technique is used to compare the same obtained SLM-WOFDM approach. The PAPR v/s CCDF curve is drawn to compare these results. The modulation used is QAM and the allowed number of phase factors (W) is 16.

**Table 1.** Simulation Parameters

| Parameter | Value |
|---|---|
| Number of subcarriers (N) | 512 |
| Oversampling factor (OF) | 1 |
| Number of allowed phase factors (W) | 16 |
| Modulation | 16-QAM |

Figure 6 and 7 represents the PAPR reduction using only SLM and SLM-WOFDM. The results show that the PAPR is reduced much effectively in proposed method compared to the PAPR of the original OFDM.

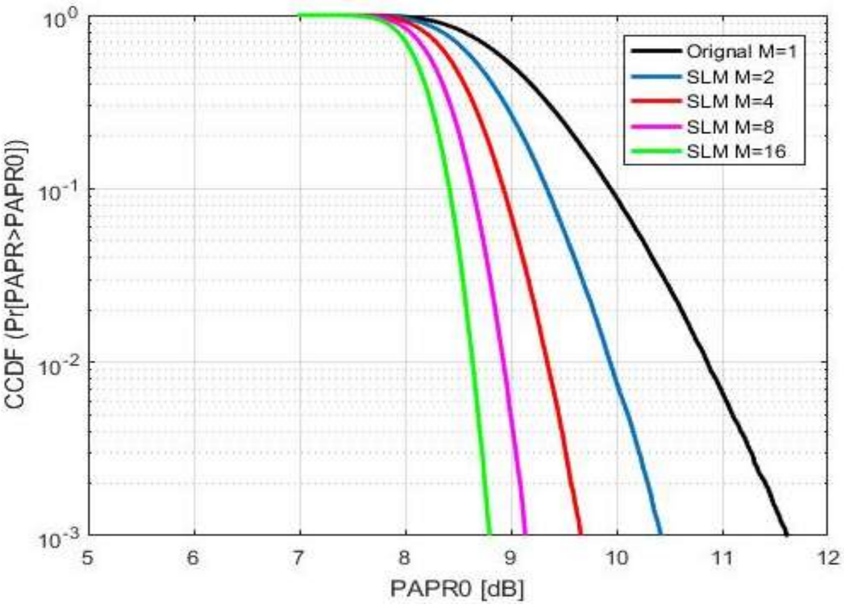


**Figure 6:** PAPR Reduction in OFDM using SLM

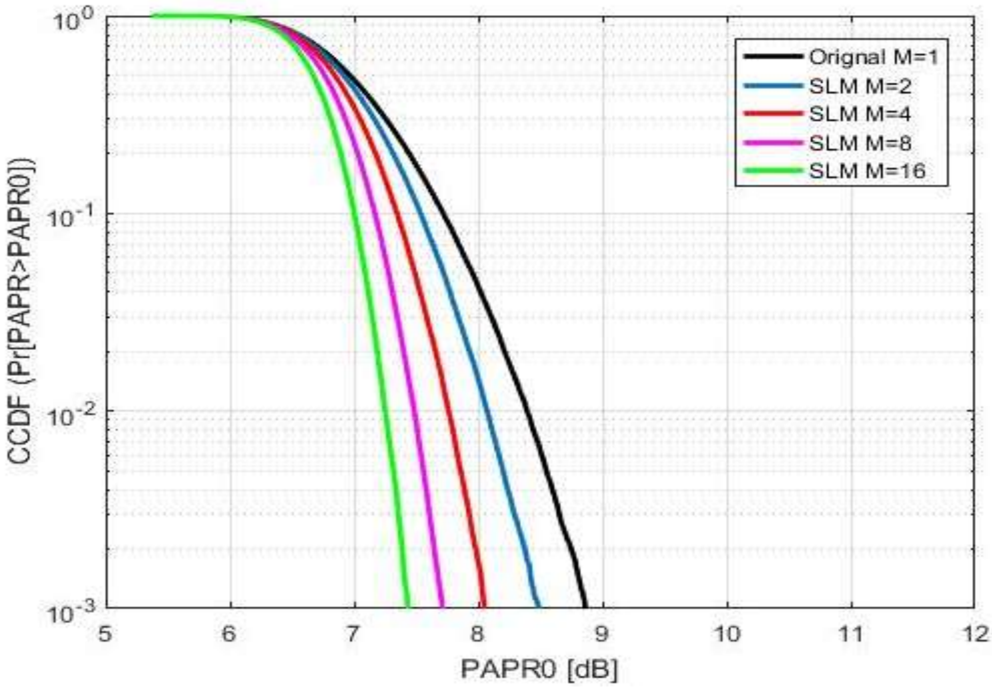


**Figure 7:** PAPR Reduction in Wavelet OFDM using SLM

## VI. CONCLUSION

In this paper, a SLM based Wavelet OFDM presented for PAPR reduction in OFDM systems. The performance of PAPR is calculated using the CCDF, and the results have been compared with conventional OFDM and the proposed reduction techniques. All the techniques provide better PAPR reduction than the original OFDM, but the results for the proposed technique are much better than the existing techniques. Also, the PAPR reduction increases as the number of SLM vectors is increased. With increasing the number of antennas, the PAPR is further improved.

**REFERENCES**

[1]. Ochiai and Imai ,"Performance analysis of deliberately clipped OFDM signals" IEEE Transactions on Communications ,Volume: 50 , Issue: 1 , Jan 2002 ,pp: 89-101
[2]. X. Wang, T. Tjhung, C. Ng, and A. Kassim, "On the SER Analysis of A-Law Companded OFDM System, Global Telecommunications Conference, 2000. GLOBECOM '00. IEEE, Vol. 2, Dec. 2000, p. 756 -760.
[3]. X. Huang, J. Lu, J. Zheng, K. B. Letaief, and J. Gu, "Companding transform for reduction in peak-to-average power of OFDM signals," IEEE Trans. Wireless Commun., vol. 3, no. 6,Nov. 2004, pp. 2030–2039.
[4]. P. Mukunthan and P. Dananjayan, "Papr reduction based on a modified pts with interleaving and pulse shaping method for stbc mimo-ofdm system," in Third International Conference on Computing Communication & Network- ing Technologies (ICCCNT). IEEE, July 2012.
[5]. S. H. Han and J. H. Lee, \An overview of peak-to-average power ratio reduction techniques for multicarrier transmission," Wireless Communications, IEEE, vol. 12, no. 2, 2005, pp. 56-65.

Rayani Sunil. "Performancce Analysis of PAPR Reduction in DWT-OFDM in comparsion with conventional OFDM System." IOSR Journal of Engineering (IOSRJEN), vol. 09, no. 06, 2019, pp. 57-62