A Comparison of Peak to Average Power Reduction Schemes for OFDM

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Abstract **- Two newly but powerful and distortion less peak to average power reduction schemes for Orthogonal Frequency Division Multiplexing (OFDM) are compared. One investigated technique is selected mapping (SLM).In this scheme the actual transmit signal is selected from a set of signals and the second investigated technique is modernized selected mapping (MSLM) where transmit signal is separate real and imaginary then selected from each set of signals then combine its. They both introduce some additional system complexity. The SLM and MSLM schemes are compared by simulation results with respect to the required reduction of PAPR of the system.**

Index Terms- **OFDM, PAPR, SLM and MSLM.**

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) [1] is a multicarrier transmission technique used in Wireless Communications [2]. The OFDM technique sub-divides the frequency spectrum available into various closely spaced carriers which are individually modulated by slow data rate streams. In this observation OFDM is similar to Frequency Division Multiplexing FDMA [3]. The channel bandwidth is divided into many channels so that in a multi-user environment each channel is allocated to a single user. However the difference lies in the fact that the carriers chosen in OFDM are much more closely spaced than in FDMA. The orthogonality principle [4] [10] essentially implies that each carrier has a null at the centre frequency of each of the other carriers in the system while also maintaining an integer number of cycles over a symbol period. OFDM has been adopted for various wireless communication Systems [5][7] such as wireless local area networks (WLANs) wireless metropolitan area networks (WMANs) digital audio broadcasting (DAB) and digital video broadcasting (DVB).OFDM is an very attractive technique for achieving high data rate in the wireless communication systems. However the OFDM signal can have very high peak-to-average power ratio (PAPR) [7][3][12] in the transmitter side due to nonlinear characteristics of amplifier then the PAPR reduction is one of the most important research interests for the OFDM systems.

II. SYSTEM DESCRIPTION

In an OFDM system shown in fig.1 [5] data is modulated in the frequency domain to N adjacent subcarriers. These N subcarriers span a bandwidth of W Hz and are separated by a spacing of $\Delta f = W/N$. The baseband signal representation of this is.

$$x(t)=\frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} X[k]e^{j2\pi\Delta f kt/T},\ t\in[0,T]$$

Where $T = 1/\Delta f$ is the symbol period and N is Number of sub carriers.

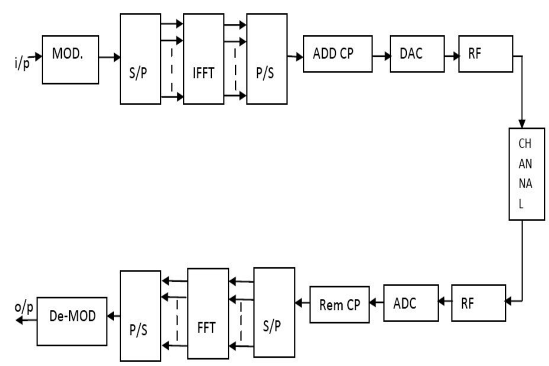

Fig.1OFDM

Orthogonal Frequency Division Multiplexing is based on a parallel data transmission technique that decreases the effect of multipath fading. Orthogonal Frequency Division Multiplexing (OFDM) is come from the fact that the digital data is sent using different carriers each of a different frequency and these carriers are orthogonal to each other.

III. PEAK-TO-AVERAGE RATIO

The PAPR is brief describes the dynamic range of the OFDM time domain signal. The very conventional definition of the PAPR for the OFDM symbol in the time domain x may be expressed as

$$PAPR = \frac{\text{Peak Amplitute of the signal}}{\text{Average value of the signal}}$$

$$PAR\{x\} = \frac{\max(x)^2}{E\left[(x)^2\right]}$$

The CCDF of the PAR is

$$\Pr\left[PAR\{x[n]\}>\gamma\right] = 1-(1-e^{-\gamma})^{N}$$

IV. SELECTED MAPPING

In a Selected mapping (SLM) shown in fig.2 [10] is a specific scheme for PAPR reduction that was introduced in [10]. SLM takes advantage of the fact that the PAPR of an OFDM signal is very sensitive to phase shifts in the frequency-domain data. PAPR reduction is achieved by multiplying independent phase sequences to the original data and determining the PAPR of each phase sequence combination. The combination with the lowest PAPR is transmitted. In other words, the data sequence X is element-wise phased by *D N*-length phase sequences. PAPR reduction is achieved by multiplying independent phase sequences to the original data and determining the PAPR of each phase sequence combination. The combination with the lowest PAPR is transmitted.

The CCDF of the PAPR in SLM OFDM symbol is

$$\text{Prob}\left[PAPR\{x^{(\tilde{d})}\}>\gamma\right] = \left[1-(1-e^{-\gamma})^{N}\right]^{D}$$

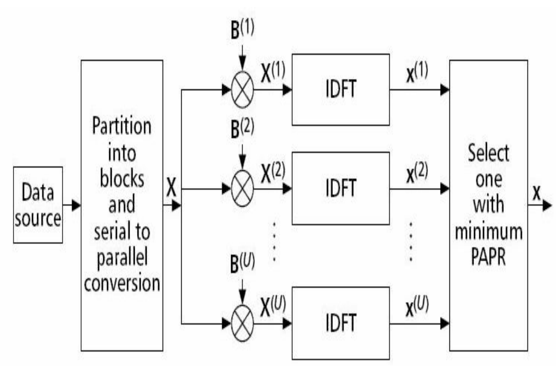

Fig.2 SLM

V. MODERNIZED SLM SCHEME

In Modernized SLM Scheme [8] firstly real and imaginary part of the complex modulating signal A_m is separated as

$A_m = A_{Rm} + jA_{Im}$ $(1 \leq m \leq M)$

Where A_{Rm} is the real part and jA_{Im} is the imaginary part of the frequency domain vectors. In the modernized SLM separate scheme the complex Baseband signal separate into real and imaginary part. These real parts converted into serial to parallel and individual phase sequence is multiply into every parallel data and selected minimum PAPR. Similarly imaginary parts converted into serial to parallel and Individual phase sequence is multiply into every parallel data which selected minimum PAPR. Both real and imaginary parts are again combining and transmit. Since the signal are real valued. The phase vector D_R and D_I have to be real. These candidates are transformed into time domain using IFFTs.then each combination of one real and one imaginary from these the best candidate with minimum PAR is selected.

The CCDF of the PAR in Modernized SLM OFDM symbol is

$$\text{Prob}\left[PAPR\{x^{(\tilde{d})}\}>\gamma\right] = \left[1-(1-e^{-\gamma})^{N}\right]_{R}^{D} + \left[1-(1-e^{-\gamma})^{N}\right]_{I}^{D}$$

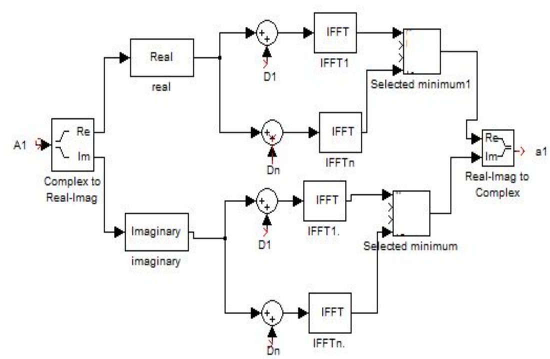

Fig.3 MSLM

IV. SIMULATION RESULTS

We are compare performence of the PAPR of both techniques SLM and MSLM using the MATLAB simulator show in fig 4.We use similar parameter and achieving 0.67db PAPR by MSLM techniques. We are also analyze SLM for various conditions show in fig 5.

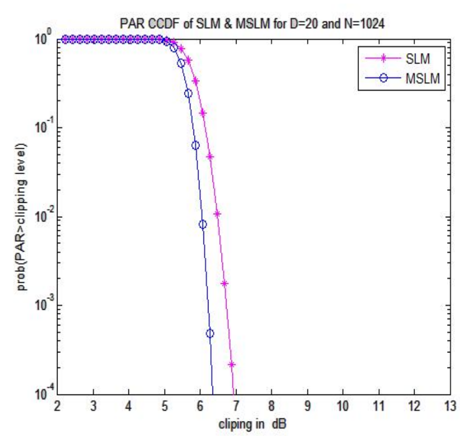

Fig.4 Simulation results MSLM and SLM

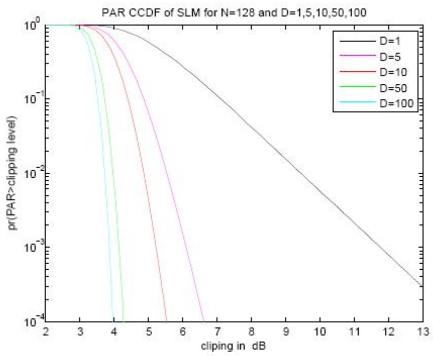

Fig.5 SLM for *N* = 128 and *D* = 1 to 100.

VII. CONCLUSION

In this paper we compared two recently proposed techniques which allow powerful but distortion less PAPR reduction for OFDM transmission. The two most powerful techniques for reducing the PAPR of the OFDM system we have presented here SLM and MSLM. As a result the MSLM technique reduces PAPR about 0.50db as compared to traditional SLM technique. The MSLM technique is best method to reduce OFDM peak power without introduce nonlinear distortion.

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