

# Modified SLM Based Peak To Average Power Ratio Reduction In MIMO-OFDM Systems

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**Abstract**— Orthogonal Frequency Division Multiplexing (OFDM) is used as a powerful multiplexing technique in wireless communication to avoid Frequency selective fading and better use of bandwidth efficiency. However, OFDM suffer from a major drawback at transmitter called Peak to Average Power Ratio (PAPR) of the transmitted OFDM signal . In order to overcome this drawback Selected Mapping (SLM) technique is commonly employed.It achieves PAPR reduction with increased computational complexity and side information requirements. In this work, modified SLM based on phase offset technique is proposed in MIMO-OFDM system. To compare the performance of proposed technique, conventional SLM (C-SLM)is considered. Results show that the proposed technique is more effective in reducing PAPR. In addition BER performance of the proposed technique is evaluated and presented.

**Keywords**— OFDM, MIMO-OFDM, PAPR, SLM, BER

## INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique that divides the available spectrum into subcarriers, with each subcarrier containing a low rate data stream. The subcarriers have proper spacing and pass-band filter shape to satisfy orthogonality .An OFDM signal of N subcarriers can be represented as,

$$x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X[k]e^{j2\pi\Delta fkt}, 0 \leq t \leq T_s \quad (1)$$

where  $T_s$  is the time duration of the OFDM signal and  $\Delta f$  is the subcarrier spacing.

### A. Orthogonality:

Orthogonality of the carrier means that each carrier has an integer number of cycles over a symbol period. In order for this orthogonality to be preserved the receiver and the transmitter must be perfectly synchronized. This means they both must assume exactly the same modulation frequency and the same time scale for transmission. The analog components, part of transmitter and receiver, must be of very high quality.

There should be no multipath channel. The advantage of OFDM system is robustness to channel fading in wireless communication environment. Frequency selective fading is reduced by increasing the number of subcarriers. By choosing the coherence, bandwidth is greater than the subcarrier spacing of the channel, each subcarrier is going to be affected by a flat channel and thus no or simple channel equalizer is needed. Orthogonal Frequency Division Multiplexing (OFDM) has several desirable attributes, such as high immunity to inter-symbol interference (ISI), robustness with respect to multi-path fading, and ability for high data rates, all of which are making OFDM to be incorporated in various wireless standards.

### B. MIMO-OFDM

The explosive growth of mobile wireless communications is producing the demand for high-speed, efficient, and reliable communication over the hostile wireless medium. In this context, Multiple-Input-Multiple-Output Orthogonal Frequency Division Multiplexing (MIMO-OFDM) has been receiving a great deal of attention as a solution for high-quality service over such a medium. MIMO-OFDM has been receiving a great deal of attention as a solution for high-quality service over such a medium. MIMO configuration promises to increase capacity and performance with acceptable BER proportionally with the number of antennas. OFDM can be combined with the MIMO architecture to increase diversity gain and to enhance the system capacity on the wireless channel. However one of the major problems posed by OFDM is its high Peak-to-Average-Power Ratio (PAPR), which affects the power efficiency of the High Power Amplifier (HPA) at the transmitter. High PAPR forces the HPA to operate beyond its linear range with a consequent nonlinear distortion in the transmitted signal. The high PAPR of the OFDM signal arises from the summation in the IDFT expression specified in Equation(1). PAPR of the OFDM signal in digital domain can be represented as in equation (2) as,

$$PAPR = \frac{\max_{0 \leq n \leq LN} |x(n)|^2}{E(|x(n)|^2)} \quad (2)$$

where  $L$  is an oversampling factor, usually  $L = 4$  is sufficient to satisfactorily approximate the PAPR of signal,  $E(\cdot)$  is the expectation operator.

OFDM is used in different WLAN standards (e.g. HIPERLAN-2, IEEE 802.11a), Wireless Metropolitan Area Networks (WMAN), Digital Video Broadcasting (DVB), Digital Audio Broadcasting (DAB), 3GPP-LTE, Asymmetric Digital Subscriber Line (ADSL) and power line communications.

### RELATED WORK

Despite of OFDM advantages, it has a major potential drawback in the form of high Peak-to-Average Power Ratio (PAPR). The high PAPR has nonlinear nature in the transmitter and it degrades the power efficiency of the system. PAPR reduction schemes can be classified according to several criteria. First, the PAPR schemes can be categorized as multiplicative and additive schemes with respect to the computational operation in the frequency domain. Selected mapping (SLM) and partial transmit sequences (PTS) are examples of the multiplicative scheme because the phase sequences are multiplied by the input symbol vectors in the frequency domain [4]. Tone reservation (TR) [5], peak cancelling, and clipping [6] are additive schemes, because peak reduction vectors are added to the input symbol vector. Second, the PAPR reduction schemes can be also categorized according to whether they are deterministic or probabilistic. Deterministic schemes, such as clipping and peak cancelling, strictly limit the PAPR of the OFDM signals below a given threshold level. Probabilistic schemes, however, statistically improve the characteristics of the PAPR distribution of the OFDM signals avoiding signal distortion. SLM and PTS are examples of the probabilistic scheme because several candidate signals are generated and that which has the minimum PAPR is selected for transmission.

Space time block codes are designed to use in multiple antenna system to correlate different signals. These coding techniques are used in MIMO-OFDM wireless systems. These techniques may be distortion or

distortion less. Distortion less techniques works better than distortion based techniques. Clipping is the simplest technique to reduce PAPR. Though clipping the OFDM signal is the simplest, low complex technique to reduce PAPR, it results in signal distortion and therefore not considered as an effective technique. High signal clipping ratio will introduce some deleterious side effects, such as increase in error bit rate and growth of in-band and out-of-band radiation. Electronic pre distortion requires a feedback path from receiver to transmitter to optimize the transmitted waveform so it cannot cope with rapid channel variations and the signal cannot be recovered at points between the transmitter and receiver.

Besides the PAPR reduction schemes, the single carrier frequency division multiple access (SC-FDMA) scheme has been proposed for alleviating the PAPR problem in uplink transmission. The SC-FDMA is a adopted multiple access scheme for uplink transmission in the long term evolution (LTE) of cellular systems by the third generation partnership project (3GPP). It is clear that the PAPR of SC-FDMA is lower than that of OFDMA, because SC-FDMA transmits the input symbols sequentially using a single carrier, while OFDMA transmits the input symbols in parallel. There have been several papers summarizing the PAPR reduction schemes [7]–[9]. In these, PAPR reduction schemes are compared according to various criteria, which include the PAPR reduction capability, average power increase, BER degradation, data rate loss, computational complexity, and out-of band radiation. Although numerous schemes have been proposed to solve the PAPR problem, no specific PAPR reduction scheme can be considered as the best solution. Since the criteria involve trade-offs, it is needed to compromise the criteria to meet the system requirements. The aim of this paper is to review the conventional PAPR reduction schemes and the various modifications of the conventional PAPR reduction schemes for achieving a low computational complexity.

#### PROPOSED SYSTEM

The proposed Modified SLM technique for PAPR reduction is shown in Figure 1. In the proposed system, transmitter generates a set of data that are then mapped with QAM constellation. Mapped symbols are then divided into sufficient candidates data blocks, all representing the same information as the original data block. Symbols in each stream are coded with Space Time Block Coder (STBC). Further, to improve PAPR reduction capability of the proposed scheme, phase offset is introduced before IFFT operation. The proposed system with phase offset is referred as known as Modified SLM (M-SLM). The sequence which offers minimum PAPR is then selected for transmission. Compared with the C-SLM scheme, the proposed scheme does not need to transmit and protect the SI, resulting in the increase of the data rate.

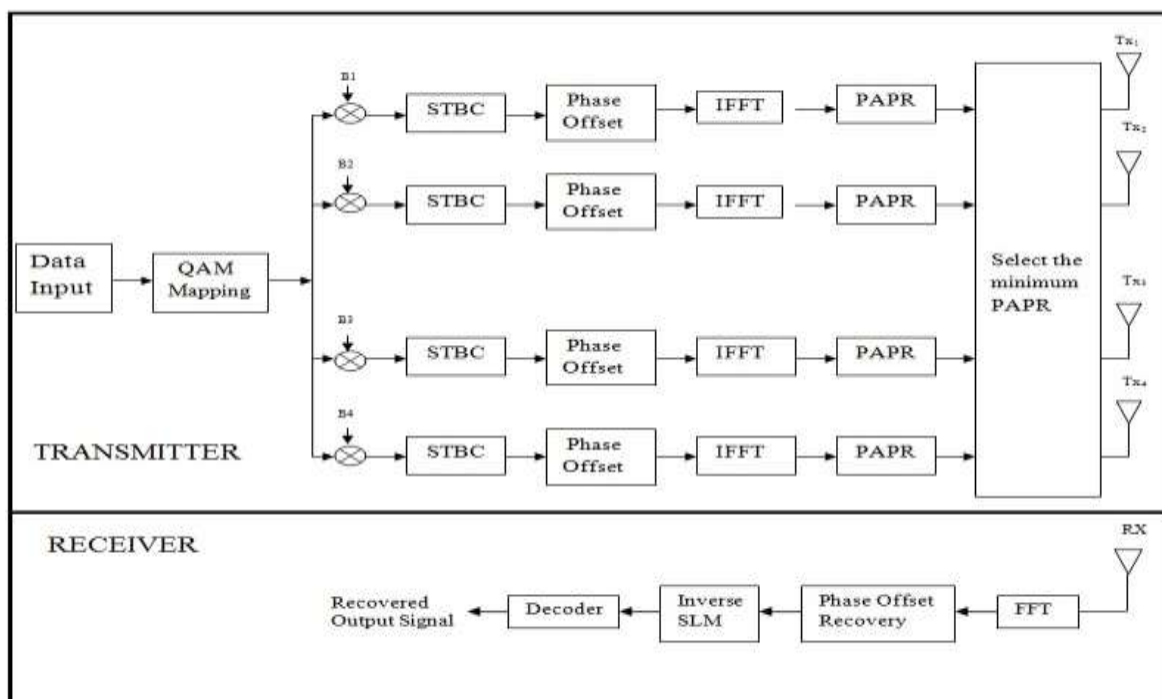


Fig. 1 Proposed M-SLM technique for PAPR Reduction

At the receiver, a MED decoder is also proposed, and the phase offset with the minimum Euclidian distance is selected as the sign of the phase rotation sequence used at the transmitter. In this way, the SI can be obtained by estimating the phase offset, since they are one-to-one correspondence. Therefore, the M-SLM scheme does not need to reserve bits for the transmission of the SI, resulting in the increase of the data rate.

#### IV SIMULATION RESULT

The proposed PAPR reduction technique in MIMO - OFSM is simulated using MATLAB. The simulation parameters are given in Table 1.

TABLE 1 SIMULATION PARAMETERS

P a r a m e t e r s	V a l u e s
M o d u l a t i o n	16 Q A M
C h a n n e l	A W G N
Number of data subcarriers (N)	1 6
Number of overlapping factors (L)	4
I F F T s i z e	6 4
Number of transmitting antennas	4
Number of receiving antennas	1
Type of Space Coding	S T B C

Table 1 summarizes the various simulation parameters used in this work. From the fundamentals, the capacity of the MIMO systems will be higher when the number of transmitting and receiving antennas increases. The proposed system is analysed under 16-QAM scheme. The maximum likelihood (ML) decoding of MIMO system with space-time block coding is performed by searching over only pairs, instead of the full set, of the possible transmitted complex symbol. Figure.2 shows the CCDF performance of the proposed M-SLM technique with conventional SLM Technique. It can be observed that at clipping probability of 0.001% of CCDF the proposed technique offers 4.0 dB reduction In Figure.2 the original refers to PAPR reduction performance without applying any reduction technique.

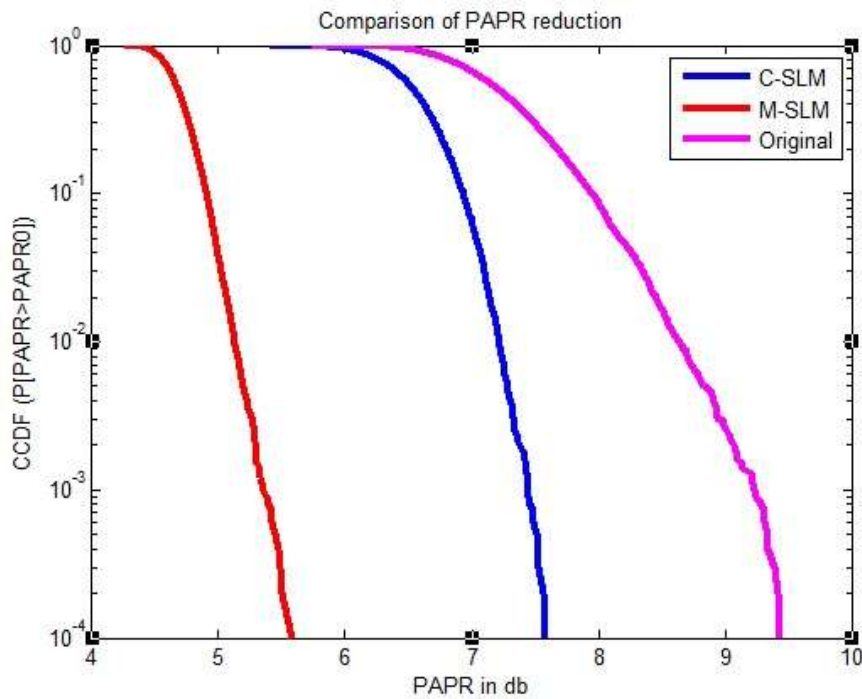


Fig. 2 CCDF performance of proposed M-SLM scheme with Conventional SLM

Figure.3 shows the BER performance of the proposed system with conventional technique. The bit error rate performance of the proposed technique is evaluated with BER of  $10^{-4}$ . It can be observed that the error performance of M-SLM is better when compared with the conventional scheme.

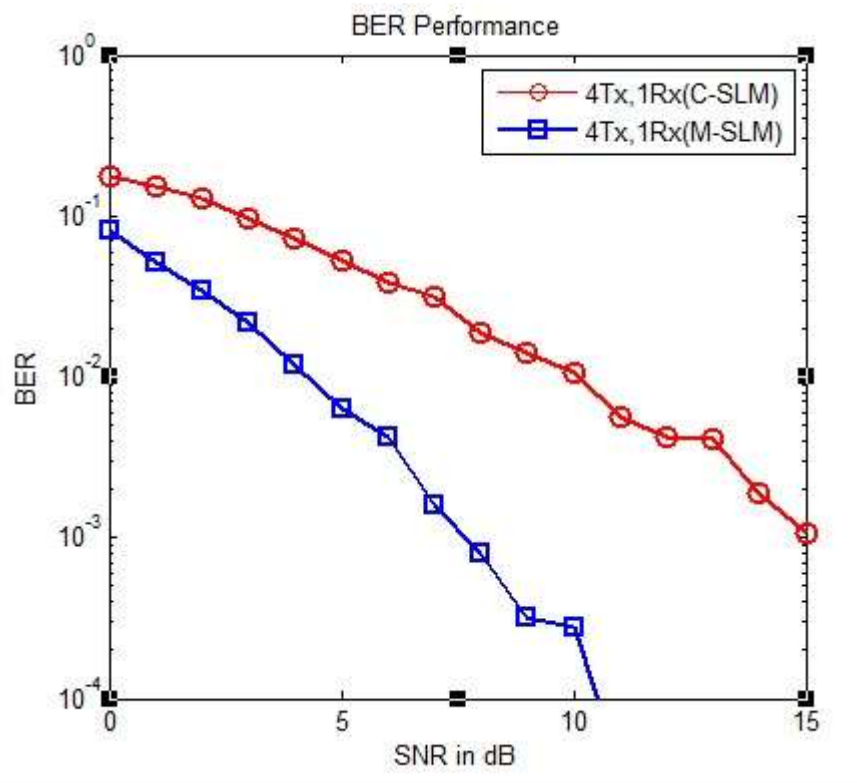


Fig. 3 BER Performance

#### IV. CONCLUSION AND FUTURE WORK

In this work a novel method for reducing PAPR through Modified SLM was proposed and compared with Conventional SLM. The simulation results shows that M-SLM gives better PAPR reduction than the C-SLM scheme. BER performance using STBC is obtained. Results shows that there is significant improvement in BER performance due to PAPR reduction. An obvious application of the scheme is to provide diversity improvement at all the remote units in a wireless system and to reduce PAPR to control the non-linear effect of power amplifier in each transmitting antenna.

The performance of the proposed system may be further analysed subjected under various mapping techniques. into various channel conditions and PAPR reduction performance measures such as power saving gain, BER analysis will be evaluated and compared with other existing schemes.

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