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# PERFORMANCE ANALYSIS OF PAPR REDUCTION TECHNIQUES IN MC-CDMA SYSTEM

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**Abstract**

MC-CDMA is the most promising technique for high data bit rate and high capacity transmission in wireless communication. One of the challenging issues of MC-CDMA system is very high PAPR due to large number of subcarriers which reduces the system efficiency. MC-CDMA or (OFDM-CDMA) multiple access has become a most likely technique for future generation broadband wireless communication system such as 4G. Reduction in PAPR have showed the way of consuming less power, improvement in spectral bandwidth, low bit error rate, lesser amount of complexity and cost. This paper describes the various PAPR reduction techniques for MC-CDMA system with used in communication channel and modulation techniques. The result it outcome with high Peak to Average Power Ratio which introduce solemn disturbances for instance lower resolution and reduction in battery life and the performance results is draw in PAPR versus CCDF.

***Keywords:*** **MC-CDMA, PAPR, CCDF, OFDM.**

## I. INTRODUCTION

Wireless communications is, by many measure, the fastest growing segment of the communications industry and the broadband wireless at the confluence of the most remarkable growth stories of telecommunication industry in recent years. WiMAX (Worldwide Interoperability for Microwave Access) is an emerging broad- band wireless technology based on the IEEE 802.16 standard. Multi-Carrier Code Division Multiple Access (MC-CDMA) is a fusion of Orthogonal Frequency Division Multiplexing (OFDM) and Code Division Multiple Access (CDMA) techniques. In MC-CDMA, information symbols are spread using orthogonal codes and spread across frequency domain. It is most promising technique for high bit rate and high speed data transmission in mobile communications. It has merit for spectral efficiency and low cost implementation. [1]- [4] It is attractive technique for 3rd and 4th generation of wireless communication. But it has critical trouble of high PAPR. With the high PAPR results that non-linear distortion in HPA (High Power Amplifier) and degrade the performance of the system. Other demerits also include like complexity of converter design, raise in interference, elevated cost, more owner consumption and reduction in batter life. To overcome this problem results in consumption of low power and enrichment in batter life and bandwidth.

MC-CDMA is a powerful multiple access technique but it is not problem free. OFDM signal has large peak to average ratio (PAPR) which severely limits its applications, and as long as basic operation of OFDM-CDMA is identical to OFDM system, this undesirable property remains. High PAPR values causes a serious problem to the power amplifier (PA) used at transmitter. The power efficiency performance at such amplifiers decreases as PAPR increases.

Therefore it is desirable to reduce PAPR by means of PAPR reduction schemes. There are number of schemes to deal with the issue of PAPR. such as, Signal Distortion, Coding, and Symbol Scrambling techniques. Signal distortion schemes reduce the amplitude by linearly distorting the MC-CDMA signal at or around the peaks. This includes techniques like clipping, peak windowing, and peak cancellation. It is the simplest technique but it causes in-band and out-band distortion. Scrambling scheme is based on scrambling each MC-CDMA signal with large PAPR. It includes techniques such as Selected Mapping (SLM), Partial Transmit Sequence (PTS). In case of PTS technique, MC-CDMA sequences are partitioned into sub-blocks and each sub-block is multiplied by phase weighting factor to produce alternative sequences with low PAPR.

## II. MC CDMA SYSTEM MODEL

In Figure 1 illustrates the obstruct description of MC-CDMA. Data symbols are transmitted simultaneously on several narrow band sub channels. The spreading of data symbols is done using Inverse Fast Fourier Transform which are then modulated and mapped in frequency domain. Using spreading sequence, the data gets spreaded by the spreader in time domain which is then applied to mapper followed by conversion. Single chip are used to modulate orthogonal overlapping subcarriers obtained by the division of bandwidth using IFFT. Inter Symbol Interference can be overcome by inserting guard interval or cyclic prefix prior converting the data into serial form. The reverse operation takes place at the receiver.

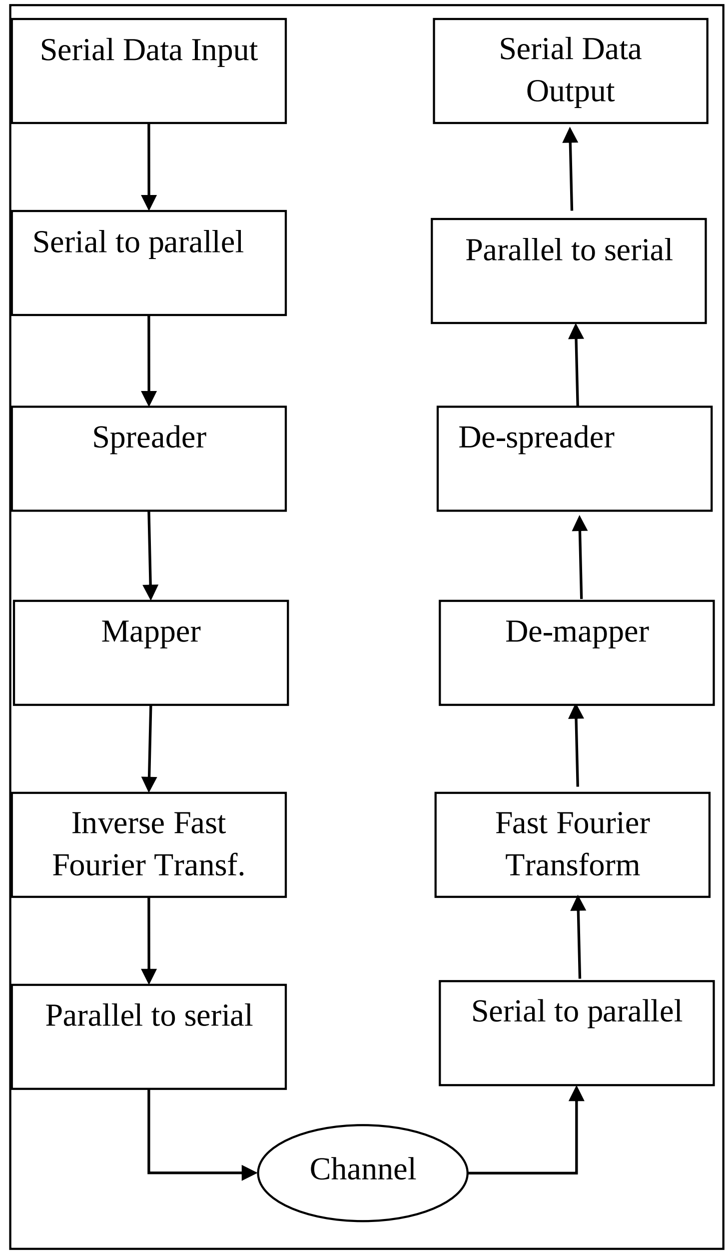


**Fig. 1: Block Diagram for MC-CDMA System**

## III. OFDM

OFDM is a modulation technique which offers quite a few interesting features to mitigate frequency-selective channel impairments [4]. Huge bandwidth savings is possible due to the orthogonality among subcarriers as shown in Figure 1.2. The high-data rate is divided into several low-data rate streams which modulate orthogonal subcarriers. The narrow band signals are multiplexed together and sent through the channel. At the receiver, the signal is de-multiplexed in reverse order creating low-data rate streams which form the original high-data rate signal. Advantage of OFDM system is the efficient channel estimation/equalization as the broadband frequency-selective channel is split into several flat-fading channels due to narrow- band subcarriers. Discrete-time OFDM signal can be written as in equation (1).

$$x_n = x(\frac{nT}{JN}) = \frac{1}{\sqrt{N}} \sum_{k=N/2}^{N/2-1} X_{(k+N)} \times \exp(\frac{j2\pi nk}{JN}),$$

$$n = 0,1,2,4,4,\ldots\ldots\ldots JN\text{-}1 \quad (1)$$

## IV. SYNCHRONOUS MC-CDMA SYSTEMS

MC-CDMA is the most promising technique for high bit rate and high capacity transmission in wireless communication. One of the challenging issues of MC-CDMA system is very high PAPR due to large number of sub-carriers which reduces the system efficiency. This paper describes the various PAPR reduction techniques for MC-CDMA system. Criterion for the selection of PAPR reduction technique and also the comparison between the reduction techniques has been discussed.

Multicarrier systems like CDMA and OFDM are now days being implemented commonly. MC-CDMA (or OFDM-CDMA) multiple access has become a most likely technique for future generation broadband wireless communication system such as 4G. We consider a synchronous $K$-user MC-CDMA system of $N$ narrowband subcarriers. The block diagram is shown in Fig. 2.4. At time $t$, the data symbol $b_k(t)$ of the user $k$, from the signal constellation $B$ is spread by the signature sequence $c_k = (c_{k1}, \ldots\ldots, c_{kn})$. These signature sequences must have low cross-correlations.

In this paper, an orthogonal Walsh-Hadamard set of size $N$ is used as signature sequences. In this case, the maximum number of active users $k_{max}$ that can be supported in the MC-CDMA system is equal to the signature sequence length $N$; i.e., $k_{max}$= $N$. The resultant $N$ chips after spreading the symbol $b_k(t)$ are modulated on the $N$ different subcarriers using the IFFT operator and then transmitted through the channel. The propagation channel is described by the complex coefficients $h_{kn}$, $k = 1; \ldots\ldots; K$ and $n = 1; \ldots\ldots; N$. The combination of spreading and channel coefficients for all users can be expressed by the L× $K$ matrix as in equation 2.

$$D(t) = \begin{pmatrix} c_{11}h_{11}(t) \ldots\ldots\ldots\ldots\ldots\ldots\ldots c_{k1}h_{k1}(t) \\ \ldots\ldots \\ \ldots\ldots \\ c_{1N}h_{1N}(t) \ldots\ldots\ldots\ldots\ldots c_{KN}h_{KN}(t) \end{pmatrix} \quad (2)$$

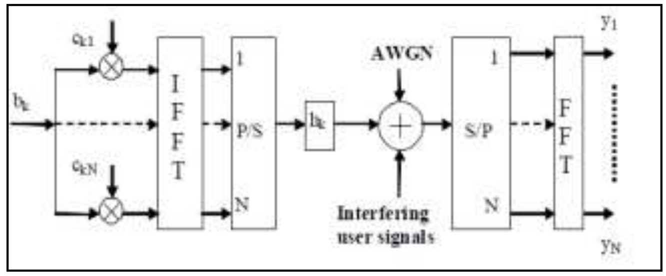


**Fig.3 Schematic diagram of synchronous MC-CDMA system**

### *(A). Companding*

The companding transformation is applied at the transmitter after IFFT block in order to attenuate the high peaks and amplify low amplitude of the MC CDMA signal, thus decreasing the PAPR. At the receiver, the de-companding process is applied by using the inverse companding function prior to FFT block in order to recover the original signal. The transmitted signal power is amplified by using HPA. However, fluctuations of signal amplitudes require expensive HPAs with very good linearity, large PAPR requires ADC and DAC with large dynamic range. Companding techniques are effective and simple for reduction of PAPR in MC CDMA. Companding technique describes compression in transmitter and expansion in receiver. µ-law companding technique, which enlarges only small signals so that average power increases, cause side lobe generation. Exponential companding scheme maintains constant average power and causes less spectrum side lobes. Exponential companding scheme offers better PAPR reduction, BER, phase error performance than µ-law companding technique.

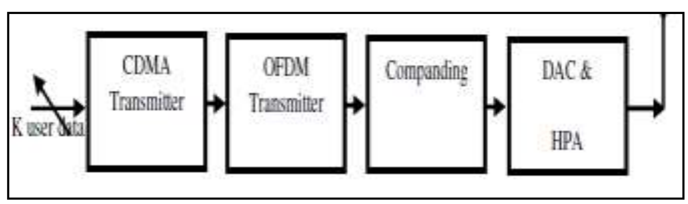


**Fig.4: MC CDMA with Companding**

Using companding technique reduces PAPR, better Power spectral density, low implementation complexity and no constraints on modulation format and subcarrier size. It has less complexity than SLM and PTS schemes. Companding technique increases the average received power and OBR. Transmitter and receiver need a compander and expander.

## V. PAPR REDUCTION IN MCCDMA

The PAPR of the MC CDMA signal p (t) is defined as the ratio between maximum in stannous power and its average power during the MC CDMA signal.

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

Where lower term is denotes expectation and complementary cumulative distribution function for MC-CDMA signal can be written as CCDF = probability (PAPR> P0).

PAPR of MC CDMA signal is mathematically defined as:

$$PAPR = 10\log_{10}\frac{\max[|p(t)|^2]}{\frac{1}{T}\int_0^T |p(t)|^2\,dt}\ dB \quad (4)$$

### A. Complementary CDF

The Complementary Cumulative Distribution function (CCDF) is used to measure the probability that the PAPR of a certain data block exceeds the given threshold. The CCDF of the PAPR of the data block is desired to compare outputs of various reduction techniques. It is defined as:

$$P(PAPR > z) = 1 - P(PAPR \leq z)$$
$$= 1 - (1 - exp(z)) \quad (5.5)$$

**Or**

$$CCDF(PAPR\,x(n)) = Pr\,(PAPR\,x(n)) > PAPR_0) \quad (5.6)$$

Where $PAPR_0$ is a certain threshold value that is usually given in decibels relative to the Root Mean Square (RMS) value.

## VI. SIMULATION RESULTS

Figure 5, 6 and 7 shows the CCDF performance of MCCDMA system with respectively 2 user, 4 user and 8 user respectively and figure 8 shows compared curve for all users (2, 4 nd 8 users) MCCDMA with companding. The figure shows that when CCDF less than 10-3 in MCCDMA with the iterative method, the PAPR is reduced by 1dB (in user 2 to 4) and 0.6dB (in user 4 to 8).

**Table. 1: Simulation Parameter**

| Sr. No. | Parameter | Value |
|---|---|---|
| 01 | IFFT | 128 |
| 02 | OFDM symbol | 512 |
| 03 | No of Users | 2, 4 and 8 |
| 04 | Number of Bits | $10^{-3}$ |
| 05 | Modulation Techniques | BPSK |
| 06 | Channel | AWGN and Rayleigh |
| 07 | PAPR Calculations | PAPR Versus CCDF |
| 08 | Cyclic Prefix | T.(Add) & R. (Remove) |

We are cosider in parameter in table1. In the transmiter side insert cyclic prefix and the reciver side remove cyclic prefix. And also cosider at the transmiter side IFFT and reciver side FFT, and midel term cosider AWGN and Rayleigh channel. The result is draw between CCDF versus PAPR with used Matlab Tool R2013a.

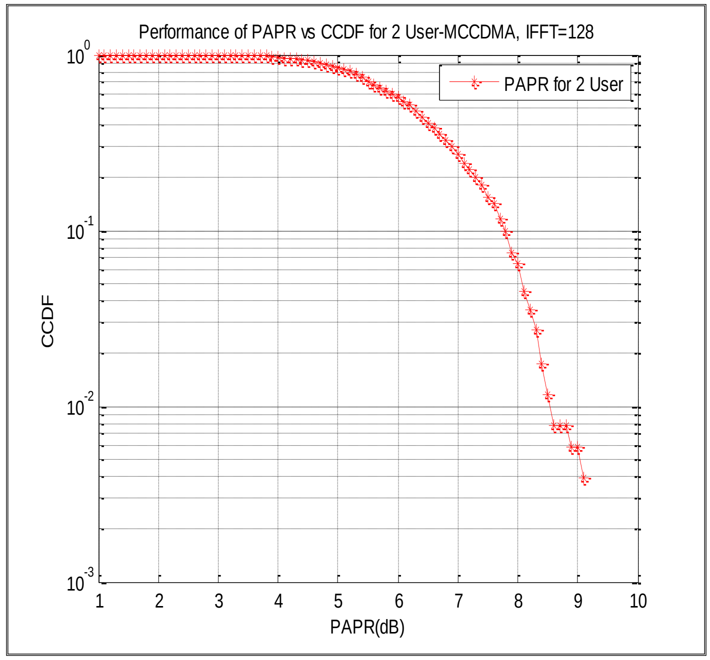


**Fig. 5: Performance of MCCDMA for two users with IFFT=128**

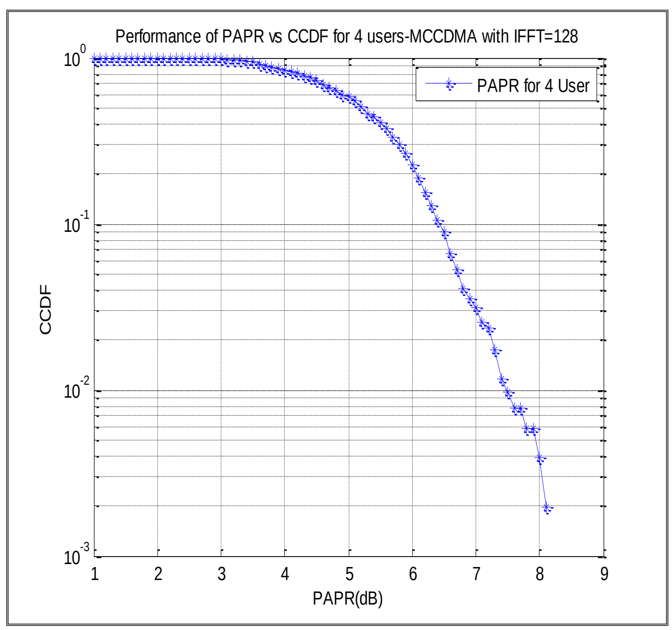


**Fig. 6: Performance of MCCDMA for four users with IFFT=128**

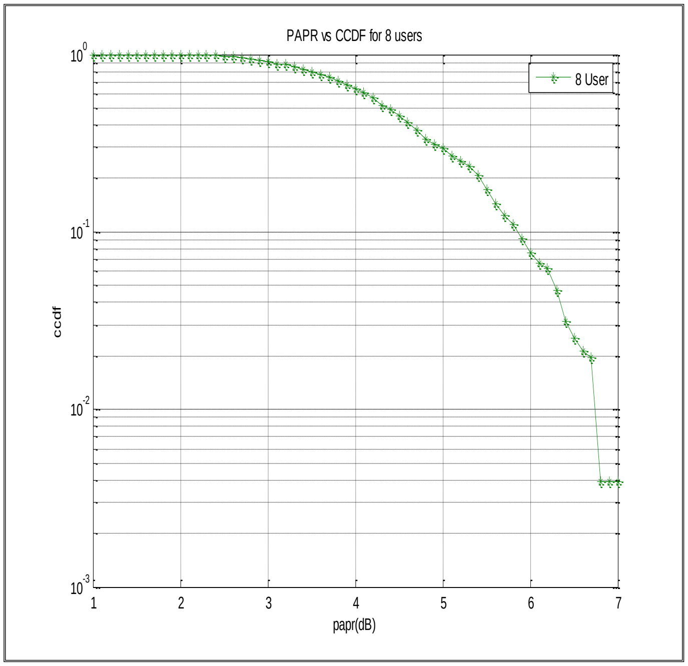


**Fig. 7: Performance of MCCDMA for Eight users with IFFT=128**

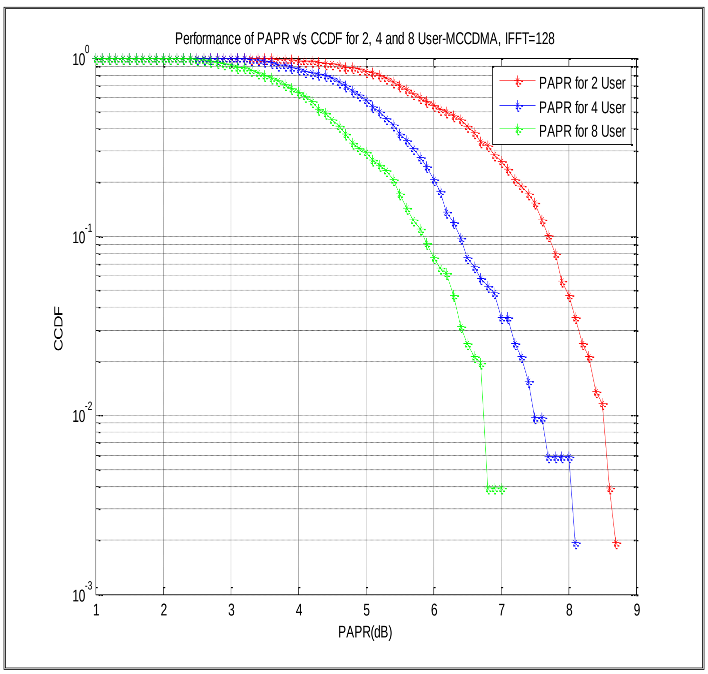


**Fig. 8: Performance of MCCDMA for two users with IFFT=128**

## VII. CONCLUSION

MC-CDMA is an important multiple access candidate for 4G wireless communication system. The transmitted signal of an MC-CDMA system exhibits a very high peak-to-average power ratio (PAPR) when large numbers of sub-carriers are used. This paper deals with PAPR reduction techniques for Multicarrier modulation transmission systems. We are observed that PAPR is increased by the number of users are increased. In future we are implement different modulation schemes and different fading channel are used and more improved our performance.

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