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High Efficiency MIMO OFDM Telecommunication Using Precoding Scheme

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***Abstract* - This research paper explain about the Multicarrier transmission is a very attractive technique for high-speed transmission over a dispersive communication channel. The PAPR problem is one of the important issues to be addressed in developing multicarrier transmission systems. In this article we describe some PAPR reduction techniques for multicarrier transmission. Many promising techniques to reduce PAPR have been proposed, all of which have the potential to provide substantial reduction in PAPR at the cost of loss in data rate, transmit signal power increase, BER increase, computational complexity increase, and so on. No specific PAPR reduction technique is the best solution for all multicarrier transmission systems. Rather, the PAPR reduction technique should be carefully chosen according to various system requirements.**

***Index Terms* - Multicarrier, communication channel, PAPR, transmit signal, computational complexity.**

I.INTRODUCTION

A few decades prior, both the sources and transmission framework were on simple organization however the headway of innovation made it conceivable to communicate information in advanced structure. The information payload limit and transmission rate expanded from kilobit to gigabit because of speed up PCs [3]. From wire to remote idea arose and analysts get accomplishment to develop remote transmitter to communicate information. Applications like voice, web access, texting, SMS, paging, record moving, video conferencing, gaming and diversion and so forth turned into a piece of life. Remote innovation gave higher throughput, tremendous versatility, longer reach, powerful spine to thereat. The vision stretched out a smidgen more to furnish smooth transmission of mixed media anyplace with assortment for minimal price and adaptability even in odd climate.

Remote Broadband Access (WBA) through DSL, T1-line or link foundation isn't accessible in provincial regions. The DSL can conceals just to approach around 18, feet (3 miles), that is the reason numerous metropolitan, rural, and provincial regions can't be served by WBA. The Wi-Fi standard broadband association may tackle this issue a piece yet it has inclusion constraints. Be that as it may, the Metropolitan-Area Wireless standard which is called WiMAX can settle these constraints [4].

There are sure contrasts between Fixed WiMAX and Mobile WiMAX. 82.16d (Rev 24) is known as Fixed WiMAX and 82.16e standard is affectionately alluded as Mobile-WiMAX. The 82.16d standard backings fixed and migrant applications though 82.16e Performance Evaluation of IEEE 82.16e (Mobile WiMAX) in OFDM Physical Layer standard backings fixed, traveling, versatile and convenient applications. The 82.16e conveys every one of the highlights of 82.16d norm alongside new determinations that empowers full portability at vehicular speed, better QoS, Performance and force control however 82.16e gadgets are not viable with 82.16d base stations as 82.16e dependent on TDD while 82.16d is on FDD. Because of other similarity issues with existing organizations, 82.16e embraced S-OFDMA and 248-FFT size. The fundamental point of versatile WiMAX is to help wandering ability and handover between Mobile Station (MS) and Base Station (BS) [3]. A few nations have effectively arranged Mobile WiMAX for business administrations. The improvement remembered some new highlights for the connection layer. Such highlights are, various kinds of handover strategies, strong force saving framework and different transmission upholds and so forth

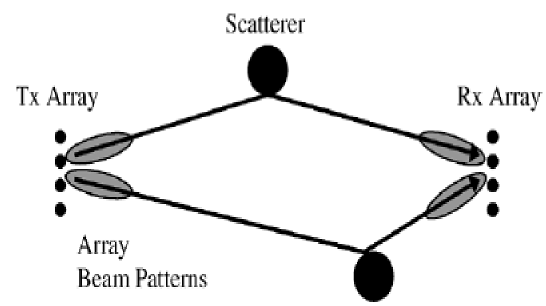
In this paper section I contains the introduction, section II contains the literature review details, section III contains the details about methodologies, section IV describe communication system model. Section V explain about Frequency Shift Keying, section VI describe the result and section VII provide conclusion of this paper.

II.RELATED WORK

Michael A. Jensen et. al. (24), [9] as per them Multiple-input–numerous yield (MIMO) remote frameworks utilize various radio wire components at communicate and get to offer further developed limit over single recieving wire geographies in multipath channels. In such frameworks, the recieving wire properties just as the multipath channel qualities assume a vital part in deciding correspondence execution. This work audits late examination discoveries concerning radio wires and engendering in MIMO frameworks. Issues considered incorporate channel limit calculation, channel estimation and demonstrating approaches, and the effect of recieving wire component properties and exhibit design on framework execution. All through the conversation, extraordinary exploration inquiries there are featured. This work has given an instructional exercise on the activity of MIMO remote correspondence frameworks and delineated how numerous recieving wires can prompt expanded framework limit with regards to multipath correspondence channels. It has likewise offered a survey of ongoing exploration exercises and discoveries identified with recieving wires and engendering in MIMO interchanges, showing the huge assortment and volume of work that has as of late been cultivated in this field. This survey has shown that issues identified with recieving wires and electromagnetic engendering assume a critical part in deciding MIMO framework execution. Moreover, the work has featured potential future exploration bearings inside this overall field, uncovering that various testing issues stay inexplicable. It will take proceeded with communitarian endeavors from specialists in electromagnetics, signal handling, and correspondence hypothesis to eventually misuse the capability of MIMO innovation through viable execution.

III.MIMO MULTIPATH COMMUNICATION

The possibility of misuse spatial (bunch) cycle to help correspondence execution has been particularly researched. for example, analyze a far-off correspondence center furnished with accomplice degree - segment recieving wire show that necessities to send information to unquestionable customers. misuse old column molding (or invalid coordinating), the structure will arrange accomplice degree bunch response to send information to one customer while putting nulls on the extra customers. As such, by mixing a novel model for every customer and cryptography a novel information stream on every model, the system will at the same time talk with all customers with an extraordinary inhabitant adequate that of one information stream. This comparable standard will be utilized in a feature point multipath channel. for example, consider the circumstance tended to in Figure 1 that shows 2 inducing methods between a transmitter and authority. If the shows will settle the two multipaths, the structure will encode a novel information stream on every multiplication way, inciting a rising in correspondence limit while not a climb in required information measure.



Fĩgure 1: Simple multipath propagation environment showing two paths between transmit and receive.

As common distant channels obliges various diverse solidly scattered (in point) ways, objective of individual multipaths is regularly unfathomable. In this manner, MIMO executions ought to use a huge load of state of the art group signal cycle to misuse the channel spatial resources. Before discussing these considerations in additional detail, regardless, we tend to starting outline a model for the MIMO correspondence system to work with the show.

IV. COMMUNICATION SYSTEM MODEL

A general model of a MÏMO communication system ïs represented in Figure 2. For simplicity, the channel is assumed time invarient over the interval of a transmission block. The figure is divided into 1) signal processing and coding (bottom) and 2) the channel (top). The radio frequency (RF) components are included in the channel since they influence the end-to-end transfer function. Ïn this system, a set of independent data streams represented by the symbol vector are encoded into discrete-time complex baseband streams at the transmitter. The coding can distribute the input symbols over the outputs (space) and/or over samples (time). The pulse-shaping block converts the discrete-time samples into continuous-time baseband waveforms and feeds them to the channel inputs (RF chains and antennas). The channel combines the input signals to obtain the element output (receive) waveform vector . The matched filter then produces the discrete-time baseband sample stream , and the space/time decoder generates estimates of the transmitted streams . For linear channel elements, the MÏMO channel input–output relationship may be written as

$$\underset{N_R\times 1}{\mathbf{y}(\omega)} = \underset{N_R\times N_T}{\mathbf{H}(\omega)}\ \underset{N_T\times 1}{\mathbf{x}(\omega)} + \underset{N_R\times 1}{\boldsymbol{\eta}(\omega)}$$

where is added substance clamor delivered by the channel (impedance in addition to commotion from the RF front end) and the lattice measurements are as indicated. Every component addresses the exchange work between the send and get recieving wire. Since the communicate vector is projected onto in (1), the quantity of free information streams that can be upheld should be all things considered equivalent to the position of. All the more by and large, the properties of, like the appropriation of its particular qualities, decide the exhibition potential for the MIMO framework. Factors, for example, recieving wire impedance coordinating, cluster size and setup, component example and polarization properties, shared coupling, and multipath engendering attributes impact these properties. Hence, helpless plan of framework parts or erroneous suspicions about the channel could prompt intense decrease in framework execution. For accommodation, we will normally drop the recurrence reliance and consider narrowband correspondence, which is advocated when the channel reaction is consistent over the framework data transmission (level blurring) or when signs are separated into narrowband recurrence containers and handled freely. This features the impact of the spatial measurement, an exceptional factor of MIMO correspondences, and overlooks the intricacy of the wide-band channel reaction.

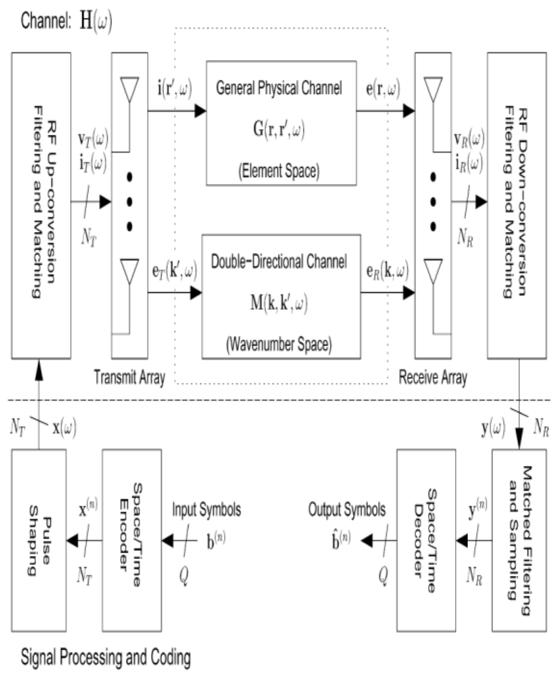


Figure 2: Block diagram of a generic MIMO wireless system.

V. FREQUENCY SHIFT KEYING (FSK)

Frequency difference near carrier frequency is called FSK. In this, the phase and the amplitude are always constant. There are several types of FSK. Most common are, Binary Frequency Shift Keying (BFSK) and Multiple Frequency Shift Keying (MFSK).

5.1 Binary Frequency Shift Keying (BFSK)

Two frequencies represent two binary values in this technique. The principle lies on the equation:

$$s(t)=\begin{cases} Acos(2\pi f_1 t) binary 1 \\ Acos(2\pi f_2 t) binary 0 \end{cases}$$

- Features:
- Less affected by errors than ASK.
- On voice transmission lines such as telephone, range till 12bps.
- This is used for high radio frequency (3 to 3 MHz).
- Suitable for LANs that use coaxial cables.

5.2 Multiple Frequency Shift Keying (MFSK)

More than two frequencies are used to represent signalling elements. The principle lies on the equation:

0 $s_i(t)=A\cos(2\pi f_i t)$ $1 \le i \le M$

$$f_{i=}f_c + (2i - 1 - M)f_d$$

➢ Features :

- Multiple frequencies are used
- More bandwidth efficient but very much affected by errors
- Bandwidth requirement is 2 Mfd in total.
- Each signal element encodes L bits (M=2L).

5.3 Phase-Shift Keying (PSK)

Phase of carrier signal is digital modulation scheme which conveys data by modulating or changing of carrier wave. The most common and widely used are Binary Phase shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK). Other PSKs are Differential Phase Shift Keying (DPSK) and Multilevel Phase Shift Keying (MPSK) etc.

As WiMAX uses Adaptive Modulation Techniques so here we will broadly discuss only BPSK, QPSK and QAM.

5.4 Binary Phase Shift Keying (BPSK):

This is also known as two-level PSK as it uses two phases separated by 18º to represent binary digits. The principle equation is,

$$s(t)=\begin{cases} A\cos(2\pi f_c t) binary1 \\ A\cos(2\pi f_c t + \pi) binary0 \end{cases}$$

$$s(t)=\begin{cases} A\cos(2\pi f_c t) binary1 \\ -A\cos(2\pi f_c t) binary0 \end{cases}$$

This kind of phase modulation is very effective and robust against noises especially in low data rate applications as it can modulate only 1 bit per symbol.

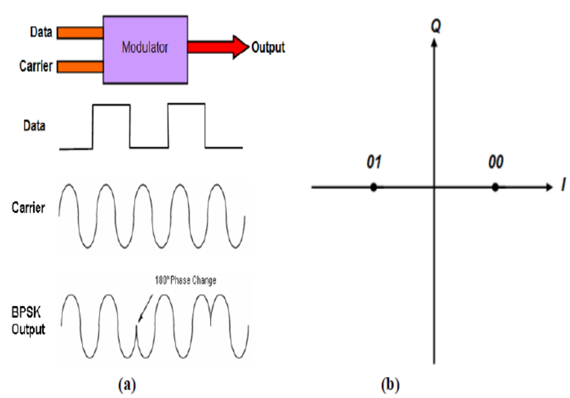


Figure 3 BPSK, (a) Block Diagram (b) Constellation

5.5 Quadrature Phase Shift Keying (QPSK)

This is also known as four-level PSK where each element represents more than one bit. Each symbol contains two bits and it uses the phase shift of π/2 means 9º instead of shifting the phase 18º. The principle equation of the technique is:

$$s(t)=\begin{cases} A\cos(2\pi f_c t + \pi/4) & 0\ 0\ 11 \\ A\cos(2\pi f_c t + 3\pi/4) & 01 \\ A\cos(2\pi f_c t - 3\pi/4) & 00 \\ A\cos(2\pi f_c t - \pi/4) & 0\ 0\ 10 \end{cases}$$

In this mechanism, the constellation consists of four points but the decision is always made in two bits. This mechanism can ensure the efficient use of bandwidth and higher spectral efficiency [27].

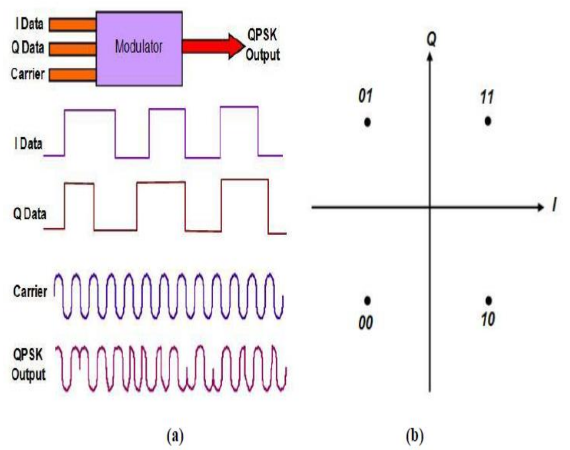


Figure 4: QPSK, (a) Block Diagram (b) Constellation

5.6 Quadrature Amplitude Modulation (QAM**)**

This is the most popular modulation technique used in various wireless standards. It combined with ASK and PSK which has two different signals sent concurrently on the same carrier frequency but one should be shifted by 9º with respect to the other signal. At the receiver end the signals are demodulated and the results are combined to get the transmitted binary input [27]. The principle equation is:

s(t)=$d_1(t)\cos 2\pi f_c t + d_2(t)\sin 2\pi f_c t$

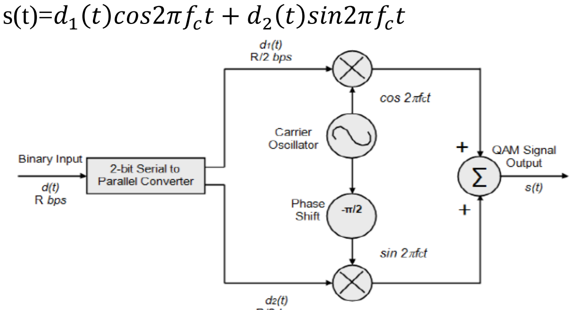


Figure 5: QAM Modulator Diagram [3]

VI.PROPOSED WORK

OFDM is known as perhaps the most positive regulation strategies for correspondence over recurrence specific remote stations, and is generally utilized in telecom guidelines. A notable downside of OFDM is that the abundancy of the time space signal fluctuates emphatically with the sent images adjusted on the subcarriers in the recurrence area, bringing about a 'peaky' signal. On the off chance that the greatest adequacy of the time area signal is excessively huge, it pushes the send intensifier into a non-straight district which mutilates the sign bringing about a considerable expansion in the blunder rate at the recipient. Over the previous decade, a broad measure of writing has been committed to Peak to Average Power Ratio (PAPR) decrease strategies. These methods are related with costs as far as transfer speed or/and communicate power. Additionally, the greater part of them expect alterations to both the transmitter and the beneficiary which makes them resistant to existing principles. Different sign portrayal strategies, like PTS and chose planning (SLM) are among the most refered to procedures. Augmentation of these calculations to various radio wire (MIMO) frameworks isn't clear. Another joined precoding and PAPR decrease procedure has been proposed for multiuser MIMO frameworks with arranged Tomlinson-Harashima precoding (sTHP). For additional subtleties and further created strategies on MIMO-OFDM top decrease see and references in that. An expansion of CP-PTS to MIMO-OFDM frameworks is presented in[6]. In the two cases, a consecutive quadratic programming (SQP) calculation is utilized to tackle the stage streamlining issue. The computational intricacy of this calculation can be restrictive for high information rate or potentially low inertness correspondence joins. The PAPR loads should be resolved again for each OFDM information block, consequently the basic calculation ought to be adequately effective to empower an ongoing preparing. In this letter, similar arrangement as CP-PTS is utilized however rather than taking care of a non-arched streamlining issue, an elective issue plan is proposed dependent on an expense work utilized in steady modulus calculations (CMAs). Likewise, the square iterative SDCMA calculation is utilized to discover the precoding PAPR loads. The subsequent computational intricacy is direct in the quantity of subcarriers. Besides, to ensure that the BER execution of the framework isn't influenced by the PAPR precoding an extra imperative is attached to the CMA target work which requires the loads to be on the unit circle. Like CP-PTS, the proposed method is straightforward to the beneficiary; this implies that it just influences the base station (BS) and it doesn't need any sign handling in the versatile station (MS). The proposed strategy doesn't work if the channel assessment abuses the smooth changes of the channel coefficients over the total OFDM block. Nonetheless, this suppositions isn't substantial in the cutting edge multiuser frameworks dependent on RB task.

We consider a conventional MIMO-OFDM/A downlink situation with one base station (BS) utilizing Mt radio wires. An OFDM block with N subcarriers is communicated from every recieving wire. The N subcarriers incorporate valuable subcarriers encompassed by two gatekeeper groups with zero energy. The valuable subcarriers are additionally gathered into asset blocks (RBs) each comprising of subcarriers. Information of at least one clients is put in these RBs and planned into the space-time area utilizing an opposite discrete Fourier change (IDFT) and space-time block coding (STBC). To permit channel assessment at the beneficiaries (versatile stations), every RB likewise contains a few pilot subcarriers that go about as preparing images. The send signal model is represented. It is viable with the WiMAX standard. Allow us first to portray the MIMO send information model in the recurrence space; for straightforwardness we consider just a solitary time block from now into the foreseeable future. The information in the q-th RB is a lattice, D(q)ЄCMl X Nb it is premultiplied with a relating shaft framing grid W(q)ЄCMl X Nb, q= 1,....., M coming about in communicate successions X(q) = W(q)HD(q) . Along with monitor stretches, they are gathered in a framework Xϵ CMl X N, where the Mt columns of this lattice address the N images to be communicated from the Mt recieving wires. The information model is

$X=W^{H}D$

where

$$\mathbf{W} = \lceil \mathbf{W}^{(1)H}, \cdots, \mathbf{W}^{(M)H} \rceil^{H},$$

and $\mathbf{D} \in \mathbb{C}^{MM_t \times N}$ is a block-diagonal matrix with structure,which includes guard intervals as well. Matrix X represents the spatial data in the frequency domain. The time-domain MIMO-OFDM transmit data model is obtained by taking the IDFT of the beam formed data matrix X, resulting in

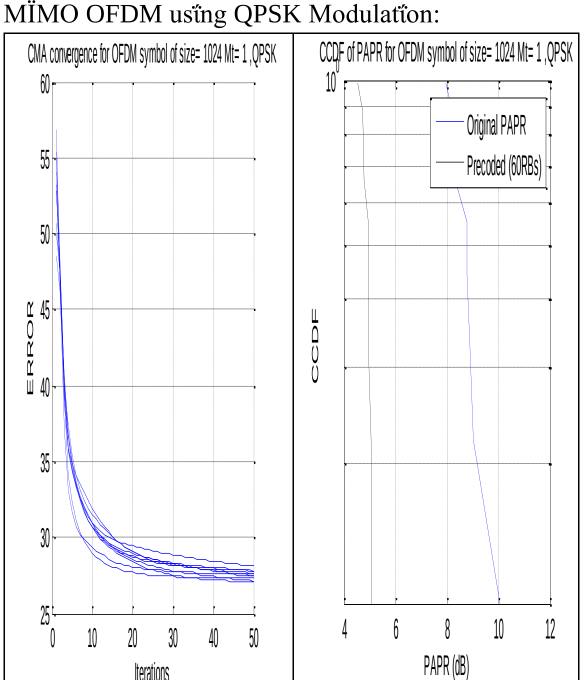
$$\mathbf{Y} = \mathbf{X}\mathbf{F}^H = \mathbf{W}^H\mathbf{D}\mathbf{F}^H$$

where $\mathbf{F}^H \in \mathbb{C}^{N\times N}$ denotes the IDFT matrix, and $\mathbf{Y} \in \mathbb{C}^{M_t\times N}$ contains the resulting transmit OFDM sequences for each of the M_t antennas. Let us further denote the time-domain data matrix $B=DF^H$; this is a full matrix. Accordingly, the beam formed OFDM block can be expressed as $Y=W^HB$

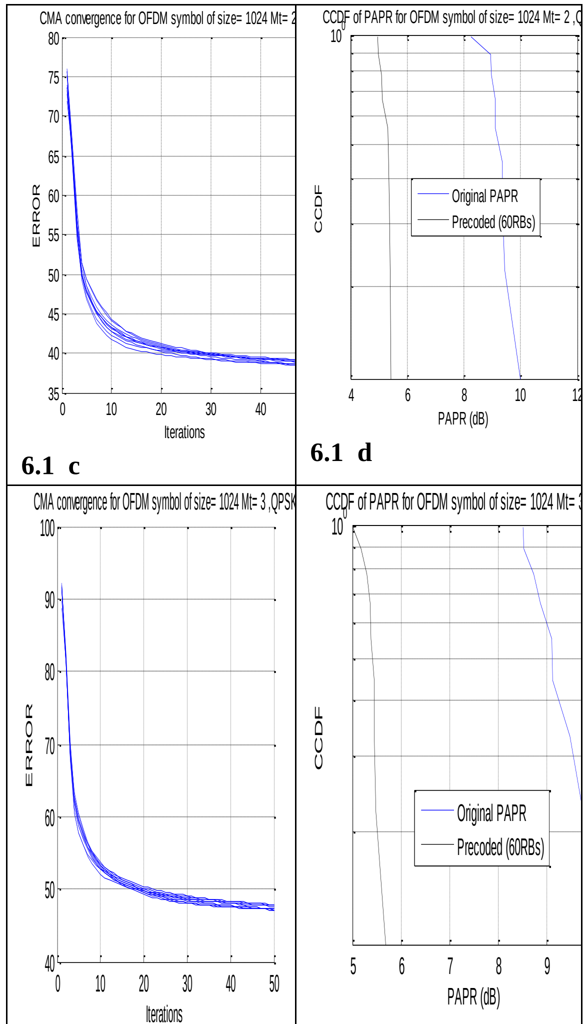
VII.RESULTS

In this section we will discuss about the performance results of the constant modulus algorithm based precoding of MIMO OFDM symbols for reducing the PAPR prior to data transmission.The PAPR reduction algorithm is developed by using MATLAB 21 software using Matlab programming scripts commands. The developed simulation is applied several times for different combinations of number of transmitting antennas and modulation techniques.

6.1 CASE 1- PAPR reductĩon performance analysĩs ĩn MĨMO OFDM usĩng QPSK Modulatĩon:



6.1 a 6.1 b



6.1 c 6.1 d

6.1 e 6.1 f

Fĩgure 6 (a ,c and e): Error convergence and (b, d and f) PAPR for QPSK for Mt= 1 , 2 and 3 .

The data is developed in binary format which is further modulated block by block in a loop of ten iterations using QPSK, 16QAM and 64 QAM modulation techniques. For each modulation the number of transmitting antenna are changed from Mt=1,2 and 3.Where Mt represents no. of antennas. When Mt =1 then the algorithm generates results for SISO otherwise for Mt=2 and 3 the results belong to MIMO OFDM.

In this manner for three types of modulation and three different number of antennas following cases are generated:

- CASE 1: QPSK Modulation-

(a) Mt=1 (b) Mt=2 and (c) Mt=3

- CASE 2: 16QAM Modulation-

(b) Mt=1 (b) Mt=2 and (c) Mt=3

- CASE 3: 64QAM Modulation-

(c) Mt=1 (b) Mt=2 and (c) Mt=3

For all the above described cases the PAPR value without and with applying the constant modulus algorithm based precoding of MIMO OFDM symbols are generated and the results are plotted in upcoming sections.

In this case we have generated random data and created the blocks of 124 OFDM symbols by applying the QPSK modulation over the binary data. After QPSK modulation the binary data becomes complex due to phase shifting and thereafter on applying the pre coding over the OFDM blocks we have plotted the results of error convergence with respect to the iteration involved in CMA algorithm to produce the data at lowest PAPR. These error convergence plots are shown in figure 4.1 a,c and e at different number of transmitting antennas at Mt=1,2 and 3.We can observe that in figure 4.1 (a,c and e) error in data after convergence at 5 iteration become consistent hence there is no need of applying CMA more than 5 iterations. In figure 6 (a) the final value of error for different OFDMA blocks is lying in the range of 25 to 3 symbols error in the block while in 6 (c) it is lying in the range of 38 to 4 while in the figure 6(e) it lies in the range of 45 to 5. Hence as we increase the transmitting antenna the error increases by 1 symbols in each block of size 124 this rise in error is very insignificant. Hence in the case of QPSK modulation there is very small rise in error in OFDMA symbols on increasing the number of transmitting antennas.

Similarly we have observed that the PAPR is reduced significantly on applying CMA algorithm after applying data pre coding with beam forming weights. In figure 4.1 (b) PAPR reduced to maximum 5 however it was in the range of 8 to 1 for Mt=1.In figure 4.1 d and f the PAPR is near about in the range of 5 to 6 max hence it shows a very large reduction in PAPR in MIMO OFDM transmission.

Above discussed results are collectively shown in a combined form on a common plot as shown in figure 6 g for symbol error convergence for Mt=1 in solid line -,Mt=2 in -.- line and Mt=3 in … line. Figure 6 h shows the collective plot of CCDF vs. PAPR for demonstrating the effect of number of antennas using CMA algorithm in Mt=1 in solid line -,Mt=2 in -.- line, Mt=3 in … line and without PAPR reduction as - - - line.

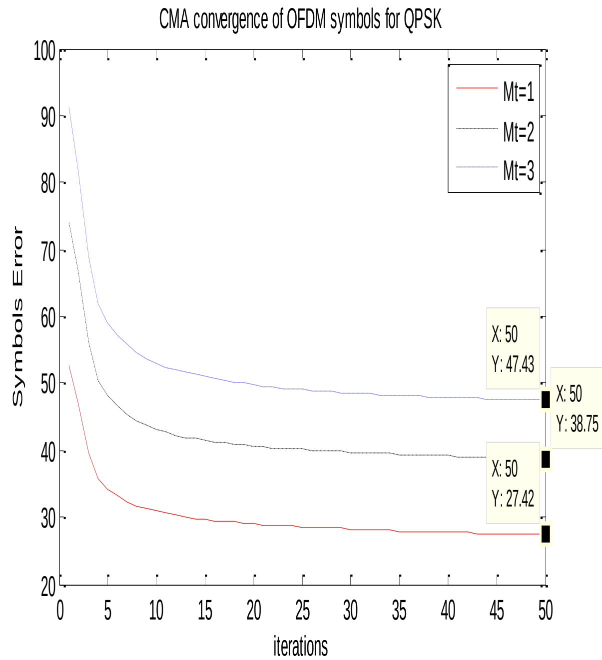


Figure 6 g : Collective plots for symbol error convergence using CMA algorithm for PAPR reduction for QPSK MIMO OFDM data transmission

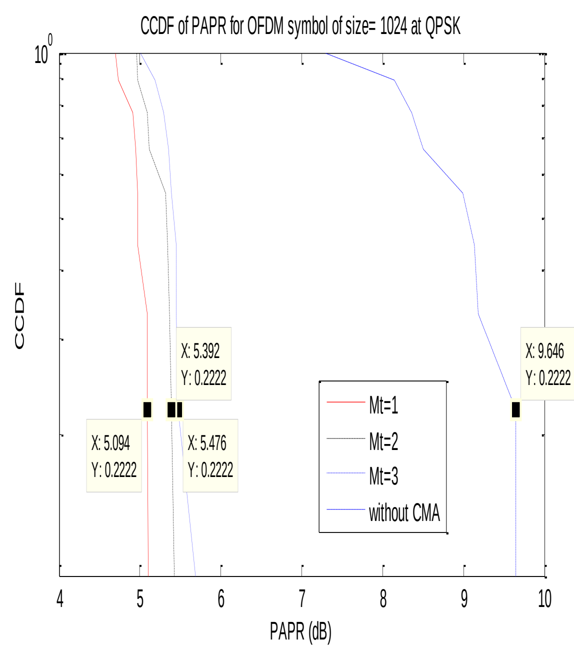


Figure 6 h : Collective plots for CCDF vs PAPR using CMA algorithm for PAPR reduction for QPSK *MIMO* OFDM data transmission.

6.2 CASE 2- PAPR reduction performance analysis in MIMO OFDM using 16QAM Modulation

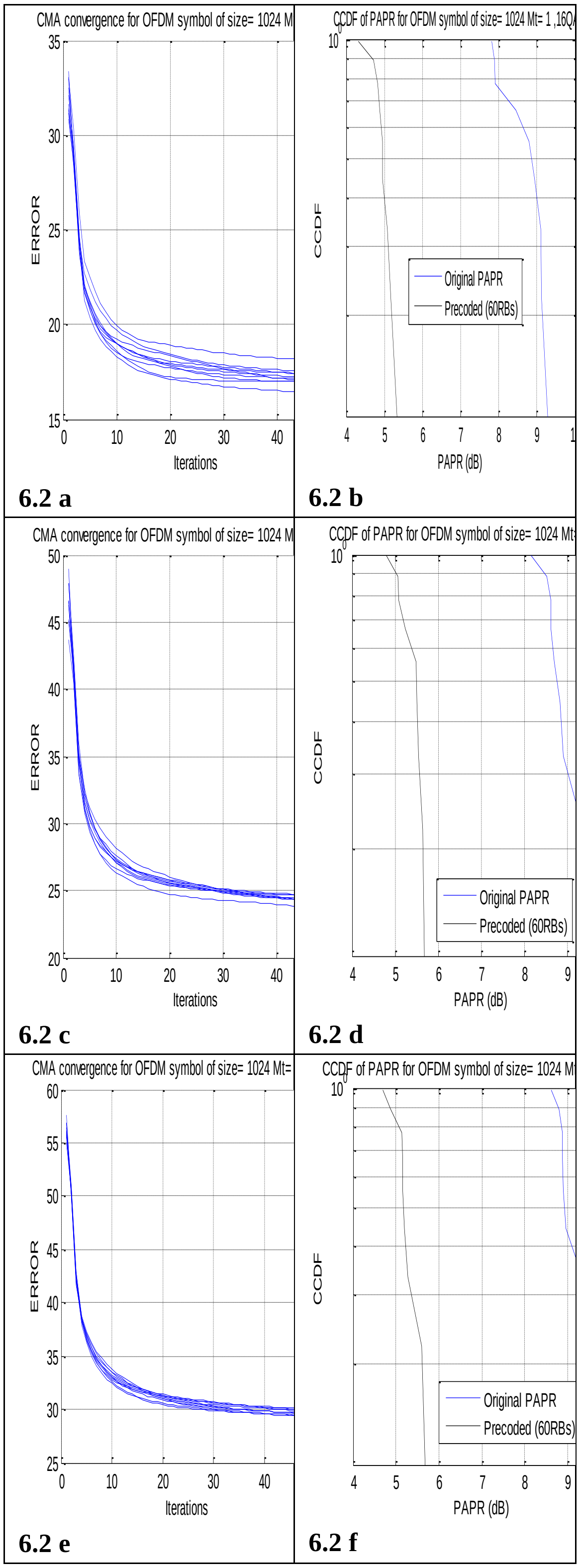


Figure 6.2 (a ,c and e): Error convergence and (b, d & f) PAPR for 16QAM for Mt= 1 , 2 and 3.

Ïn this case we have generated random data and created the blocks of 124 OFDM symbols by applying the 16QAM modulation over the bĩnary data. After 16QAM modulation the binary data becomes complex due to phase shifting and thereafter on applying the pre coding over the OFDM blocks we have plotted the results of error convergence with respect to the iteration involved in CMA algorithm to produce the data at lowest PAPR.

VIII.CONCLUSION

The OFDM based data communication is most commonly applicable and very favorable modulation method for transmission purpose over frequency division multiplexed wireless medium that is why it is widely accepted in all the standard telecommunication. In this thesis we are focusing on the drawback of OFDM which arises due to the variation in the amplitude of the time domain signal during the course of transmitting the symbols after modulation as the subcarriers in the frequency domain space generating a signal having very high abrupt peaks. The peak amplitude of such time domain signal due to their excessively high value drives the response of the transmitting amplifier in a non-linear operation zone which causes signal distortion in the data which results in a substantial rise in the error in received symbols. We have played out an immense writing study during the advancement of calculation for assessing PAPR .This writing review has exhibited that the Peak to Average Power Ratio (PAPR) decrease strategies are ordinarily connected with misfortunes identified with decrease in transfer speed and expansion in necessity sending end influence. It has been additionally seen that the majority of PAPR decrease procedures require redesign in component of both the closures at transmitter and just as at the collector which makes them contradictory with the current OFDM telecom principles. On account of MIMO OFDM different sign portrayal strategies PTS and chose planning (SLM) are discovered to be the most regularly explored and proposed procedures however there expansion the numerous receiving wire (MIMO) frameworks is exceptionally convoluted.

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