PAPR REDUCTION IN OFDM USING DCT PRECODED SLM TECHNIQUE

Submitted in partial fulfillment of the requirements for the degree of M. Tech

Submitted By

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ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation system, which is broadly used in various wireless communication organisms and standards due to its high data rate, high spectral efficiency and robustness to multipath fading channel. However, peak-to-average ratio (PAPR) reduction and intercarrier interference (ICI) cancellation are two major challenges in implementing an OFDM system. High PAPR results from large envelope fluctuations in OFDM signal which requires a highly linear power amplifier (PA). Power amplifiers with large linear range are bulky, costly and difficult to manufacture. Therefore, various PAPR reduction techniques have been proposed in literature to reduce the PAPR of OFDM signal. In OFDM system the subcarriers are narrowband and require tight frequency synchronization between the transmitting and receiving ends. A small carrier frequency offset (CFO) between transmitter and receiver local oscillators can disturb the orthogonality among the subcarriers and cause intercarrier interference (ICI).

The PAPR of the OFDM signal can also be reduced by using PTS or SLM technique. But both of them require side information (SI) to be conveyed to the receiver for correct detection of the data symbols, which not only degrades the bandwidth efficiency but also degrades the error performance of the OFDM system in the case of erroneous detection of SI. Therefore, we have proposed in this thesis a concentric circle mapping scheme to completely eliminate the requirement of SI in PTS and SLM based OFDM systems using four pure rotational phase xiii factors (1, j, -1, -j). The proposed scheme not only eliminates the requirement of SI at the receiver but also simplifies the receiver structure. Mathematical and simulation results confirm the outperformance of CCM-PTS over MPSM-PTS. The CCM-PTS scheme achieves almost same PAPR reduction capability as existing Multipoint Square mapping PTS (MPSMPTS).

This method has ability to reduce PAPR which depends upon the number of required bits and their design. SLM can produce multiple times domain OFDM signal that are asymptotically independent .SLM generate several OFDM signals in a special manner and select the lowest PAPR for actual transmission .The number of required bits as side information in this technique is less. This technique does not increase the power of OFDM signal but bandwidth expansion occurs. The implementation complexity of this method is high. This technique gives output distortion lessly. The model of this technique consist moderate complexity. In SLM one favorable transmit signal is selected by the transmitter from a set of sufficiently different signals which all represents the same information.

Presence of Doppler shifts and frequency and phase offsets in an OFDM system causes loss in orthogonality of the sub-carriers. As a result, interference is observed between sub-carriers. This phenomenon is known as inter - carrier interference (ICI).

In this thesis, we present a new DCT precoder based SLM technique for PAPR reduction. In the proposed system we make use of DCT based precoder which is less complex then other precoders after the multiplication of phase rotation factor and before the IFFT in the SLM-OFDM system. Our proposed DCT precoder based SLM technique is signal independent and it does not require any complex optimization technique either.

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CHAPTER-1

LITERATURE SURVEY

1.1 Introduction

High information rate is needed in numerous ongoing remote sight and sound applications. Conventional single bearer regulation methods can accomplish just constrained information rates because of the limitations forced by the multipath impact of remote channel and the collector multifaceted nature. In single bearers frameworks, as the information rate in correspondence framework expands, the image term gets decreased. Along these lines, the correspondence frameworks utilizing single transporter adjustment experience the ill effects of extreme between image impedance (ISI) caused by dispersive-channel motivation reaction, and in this way require an unpredictable evening out plan. Symmetrical Frequency Division Multiplexing (OFDM) is a potential possibility to satisfy the necessities of present and cutting edge remote correspondence frameworks.

The transmitted flag faces different hindrances and surfaces of reflection, because of which they got signals from a similar source reach at various circumstances. This offers ascend to the development of echoes which influence the other approaching signs. Dielectric constants, penetrability, conductivity and thickness are the primary components influencing the framework. Multipath direct engendering is formulated in such a way, to the point that there will be a limited impact of the echoes in the framework in an indoor situation. Measures are should have been taken keeping in mind the end goal to limit resound so as to maintain a strategic distance from ISI (Inter Symbol Interference).

Unfortunately the significant disadvantage of OFDM transmission is its substantial envelope change which is measured as Peak to Average Power Ratio (PAPR). Since control speaker is utilized at the transmitter, in order to work in a flawlessly direct locale the working force must lies beneath the accessible power. For decrease of this PAPR part of calculations have been produced. The majority of the strategies has a type of points of interest and detriments. Cutting and Filtering is one of the fundamental method in which some piece of transmitted flag experiences into bending. Additionally the Coding plan decreases the information rate which is bothersome. On the off chance that we consider Tone Reservation (TR) system it likewise permits the information rate misfortune with more plausible of expanding influence. Again the strategies like Tone Injection (TI) and the Active Constellation Extension (ACE) having a criteria of expanding force will be unfortunate if there should arise an occurrence of intensity requirement condition. In the event that we go for the Partial Transmit Sequence (PTS) and Selected Mapping (SLM) system, the PTS procedure has more many-sided quality than that of SLM strategy

This Selected Mapping is one of the promising technique due to its simplicity for implementation which introduces no distortion in the transmitted signal. It has been described first in i.e. to be known as the classical SLM technique. This technique has one of the disadvantage of sending the extra Side Information (SI) index along with the transmitted OFDM signal. Which can be avoided using a special technique described.

OFDM is a strategy for encoding advanced information on numerous transporter frequencies. OFDM is a multicarrier regulation procedure which is utilized as a part of broadband remote correspondence framework like Wi - Max, DVB-T and future 4G on account of its different highlights multipath postpone spread resilience otherworldly transmission capacity proficiency, insusceptibility to recurrence particular blurring channels. OFDM signals is the superposition of a high number of regulated sub channel flags that may show a high quick flag crest as for the normal flag level. An OFDM flag comprises of various freely balanced subcarriers, which can give a huge top to normal power proportion and these subcarriers are commonly symmetrical that is the reason its name happen as symmetrical recurrence division multiplexing. OFDM is a blend of balance and multiplexing. It changes a flag from recurrence area to time space. The time area OFDM flag is constituted by the entirety of complex exponential capacities, whose amplitudes and stages are controlled by the information images transmitted over the diverse transporters. OFDM is a multicarrier framework which utilizes Discrete Fourier Transform (DFT) or Fast Fourier Transform (FFT).The fundamental standard behind OFDM procedure is that high rate information stream is part into various lower rate information stream and transmit them at the same time finished different number of transporters. In OFDM the cyclic prefix is utilized for bring down multi-way bending.

Discrete Multi-Tone (DMT) is a special case of OFDM in which different sub-carriers whose signal to noise ratio (SNR) values is utilized in these ways. The first way is the sub-carrier with high S/N ratio carry more bits and the second one is the sub-carriers with low S/N carry less bits due to frequency selective fading. OFDM is so popular for new broadband systems due to the reason that most broadband system contains multipath transmission and it gives a simple way of dealing with multipath. But this multipath transmission causes some attenuation in the frequencies of the signals; this problem is corrected in the receiver side. OFDM is a special case of FDM. As an analogy, a FDM channel is like water which flows out of a faucet while OFDM signal is like a shower. In a faucet all water comes in one big stream and cannot be sub-divided. OFDM shower is made up of a lot of little streams.

The concentration of this thesis work is “especially upon the Selected Mapping technique. Here the three important analysis of this technique has been done. Out of them one is, how to avoid the transmission of extra information along with the OFDM signal which will be discussed in the section avoiding the SI index Transmission. Another one important analysis of this technique is how to reduce the computational complexity. Also one important analysis is to be done about the mutual independence between the alternative phases vectors used in this technique. One technique also being proposed which has an advantage of reducing the PAPR simultaneously reducing the computational complexity in comparison to that of the Classical SLM. In addition to this the proposed technique also avoids the sending of extra SI index”

1.2 IMPORTANCE OF ORTHOGONALITY

OFDM framework likewise gives the preferred standpoint that the neighboring subcarriers are exchanged with no impedance this is conceivable in light of the fact that the subcarriers in the OFDM framework are symmetrical to each other. Subcarriers are said to be symmetrical when maxima of one subcarrier covers with the minima of another subcarrier, numerically, this condition can be communicated that subcarrier dispersing must be a numerous of 1/Ts. For keeping up symmetry in OFDM frameworks the Fourier changes are utilized.

Symmetrical recurrence division multiplexing has additionally been received for various communicated measures from DAB Digital Radio to the Digital Video Broadcast guidelines, DVB. It has likewise been received for other communicated frameworks too including Digital Radio Mondale utilized for the long medium and short wave groups.

OFDM is a type of multicarrier adjustment. An OFDM flag comprises of various firmly divided tweaked bearers. At the point when balance of any shape - voice, information, and so forth is connected to a bearer, at that point sidebands spread out either side. It is fundamental for a beneficiary to have the capacity to get the entire flag to have the capacity to effectively demodulate the information. Accordingly when signals are transmitted near each other they should be dispersed with the goal that the collector can isolate them utilizing a channel and there must be a protect band between them. This isn't the situation with OFDM. Despite the fact that the sidebands from every transporter cover, they can even now be gotten without the obstruction that may be normal since they are symmetrical to each another. This is accomplished by having the bearer dispersing equivalent to the corresponding of the image time frame.

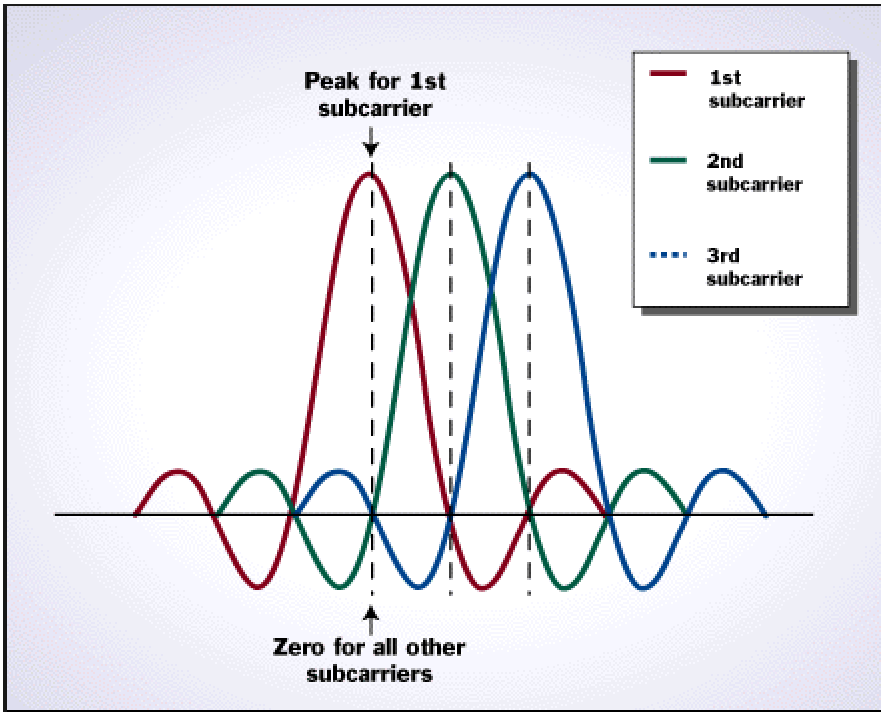


Fig 1.1 Spectra of OFDM signals [4]

1.3 NEED OF FFT IN OFDM SYSTEM

In an OFDM framework higher number of subcarriers is attractive on the grounds that progressively the quantity of subcarriers more information can be conveyed by the framework and more data can be sent and furthermore in light of higher number of subcarriers less measure of information is lost if there should be an occurrence of any uncertainty happening in the channel. Be that as it may, producing of higher number of subcarriers prompts expanded many-sided quality of the framework since it might require vast number of oscillators and channels at both the transmitting and furthermore at the less than desirable end. Anyway by taking IDFT of the OFDM motion at the transmitter side we can get diverse discrete estimations of the information flag prompting N-point IDFT of the data flag. To invert this activity DFT can be performed at the beneficiary side of the got flag. The superposition of indivually tweaked subcarriers is finished by the opposite Fourier change (IFFT). IFFT/FFT obstructs in an OFDM framework are proportional to an IDFT and a DFT of the transmitted and got OFDM flag, which gives favorable position of lower calculation many-sided quality. Since OFDM signals are symmetrical the beneficiary ascertains the range at the most extreme purpose of subcarriers because of which the got flag can be demodulated utilizing FFT with no impedance and because of this there is no need of sifting which makes OFDM framework simple and proficient for all intents and purposes.

1.4 OFDM BLOCK DIAGRAM

A basic block diagram is “shown in figure 1.2 .the detailed description of this block diagram is as The figure 1.2 describes about a general digital communication system blocks. The A/D converter being used to convert the analog source to the digital i.e. in the form of binary sequences. The source encoding takes place to compress the transmitted digital data up to an extent such that it can be received without any loss. There are some basic source coding techniques are available like the Hoffman coding and Shannon-Fano coding. The objective of source encoding is to remove redundancy from the source. The sequence of binary digits from the source encoder also known as information sequence is passed to the channel encoder. The channel encoder add redundant bits to the information sequence from the received signal for the reliable communication. The channel encoder maps k information bits into a unique n bit sequence called code word. The ratio n k is a measure of the redundancy introduced by the channel encoder and the reciprocal of this ratio is called code rate. The output of the channel encoder is passed to the digital modulator."

"The data to be transmitted on an OFDM signal is spread across the carriers of the signal, each carrier taking part of the payload. This reduces the data rate taken by each carrier. The lower data rate has the advantage that interference from reflections is much less critical. This is achieved by adding a guard band time or guard interval into the system. This ensures that the data is only sampled when the signal is stable and no new delayed signals arrive that would alter the timing and phase of the signal".

The computerized modulator maps the paired data arrangement into flag waveforms. The tweak might be twofold or m−ary. In twofold balance two particular waveforms are utilized to speak to the parallel digits 0 and 1 while in m−ary tweak m = 2b unmistakable waveforms are utilized to speak to a double expression of b bits. The regulated wave frame is being transmitted from the transmitter to the recipient through channel. In the channel because of expansion of commotion the transmitted flag ends up undermined. The wellsprings of clamor are warm commotion, climatic clamor, artificial clamor and so on., which are arbitrary in nature and for the most part capricious. At the less than desirable end the advanced demodulator comprises of coordinated channel compose finder or correlator write locator changes over the got flag waveforms into paired grouping, which speak to the assessed word. The yield from the demodulator is passed to the channel decoder that recoups the data arrangement from the learning of the code.

"The average probability of a bit-error at the output of the decoder is a measure of the performance of the demodulator decoder combination. However the probability of error is a channel characteristics, coding, modulation, demodulation and decoding techniques. Finally the source decoder reconstructs the output from the source that was transmitted. The reconstructed signal is an approximation of the source output as the encoders and decoders have introduced errors and distortion to the signal. The difference is a measure of the distortion introduced by the digital communication system. This encoded signal will be passed through the digital to analog converter and finally received by the user".

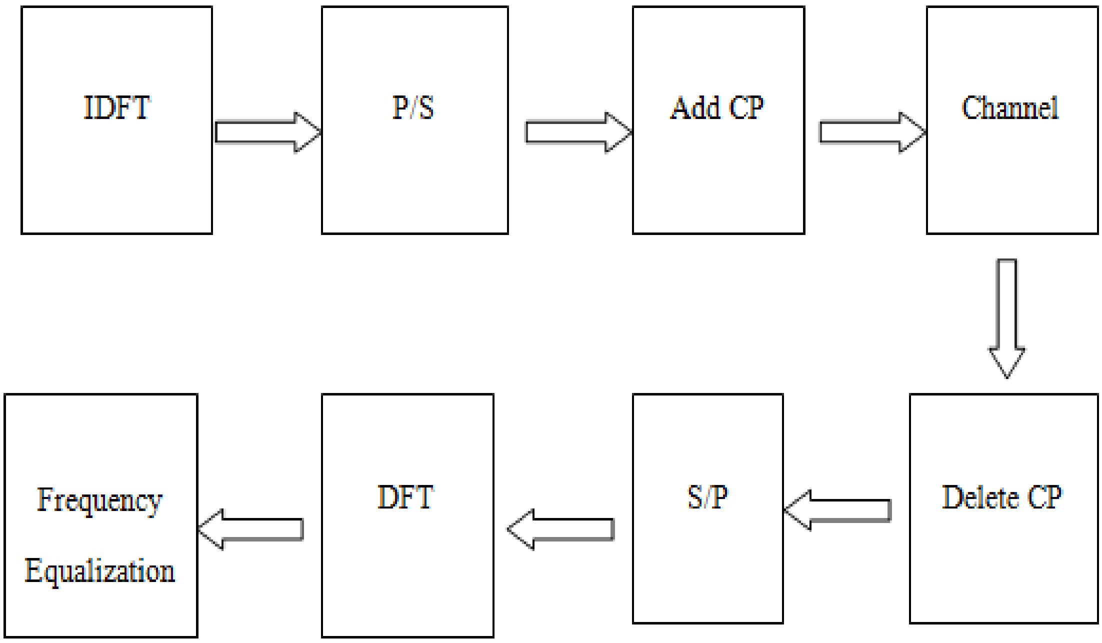


Fig 1.2 OFDM System Block Diagram

1) Initial a vast or wide transmission capacity flag is separated into a few little data transmissions or sub groups. For instance let us say we have a transfer speed of 'B MHz' at that point for M number of subcarriers this data transmission is isolated as each subcarrier gets the transfer speed of B/M as a result of this the image rate is kept up however the subcarriers encounter level blurring or ISI free transmission.

2) The 'M' subcarriers are currently balanced by utilizing Inverse Fast Fourier Transform (IFFT). This is done as such as to utilize a wideband flag rather than 'M' narrowband subcarriers.

3) "Then the most important step is adding cyclic prefix. Cyclic prefix is added to make the subcarriers orthogonal. So a cyclic prefix of length 'x' is added to the resultant signal after IFFT operation. So now we have 'M' subcarriers and length 'x' prefix

added to it , therefore the total length of the signal becomes ‘M+x’ and these ‘M+x’ signals are sent serially through the wideband channel”.

4) “At the receiver side the cyclic prefix is discarded and M received symbols are demodulated using Fast Fourier Transform (FFT) operation”.

5) “Then equalization is performed on the received signal to remove the channel effects and restore the original signal”.

1.5 CYCLIC PREFIX

Utilization of cyclic prefix is a key component of empowering the OFDM flag to work dependably. The cyclic prefix goes about as a cradle area or watch interim to shield the OFDM signals from entomb image obstruction. This can be an issue in a few conditions even with the much lower information rates that are transmitted in the multicarrier OFDM flag. The essential idea driving the OFDM cyclic prefix is very direct. The cyclic prefix is made so each OFDM image is gone before by a duplicate of the end some portion of that same image. Diverse OFDM cyclic prefix lengths are accessible in different frameworks. For instance inside LTE a typical length and a broadened length are accessible and after Release 8 a third expanded length is likewise included, despite the fact that not regularly utilized.

In OFDM framework the information is separated into 'N' sub streams or subcarriers and the image time of the flag gets improved by N, the benefit of expanding the image time is that the defer spread is lessened and this diminishes ISI. To destroy Intercarrier Interference ICI a protect time is included between each OFDM image subsequent to taking IFFT. The monitor time is included by the cyclic expansion of the OFDM flag that is the some front piece of the OFDM flag is added to the OFDM image toward the end this is known as cyclic augmentation. The part which is consistently reached out toward the end is known as cyclic prefix.

“If the length of cyclic prefix is equal to or longer than the maximum delay spread of the channel the interference of subsequent symbols will reduce which will reduce ISI. If cyclic prefix is added to the signal then the signal appears to be the circular convolution of input signal x(n) and the channel h(n)”.

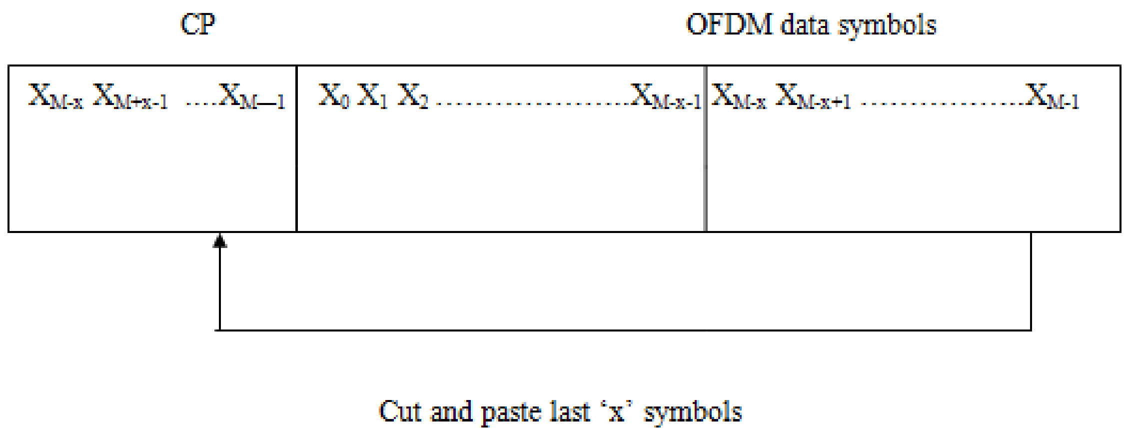


Fig 1.3 OFDM Cyclic Prefix

"But the addition of cyclic prefix will require large amount of power and power will be wasted. The power penalty due to cyclic prefix is given by":

$$Power\ Loss = \frac{M}{M+x} \tag{1.1}$$

Here M is length of OFDM symbol and 'x' is the length of cyclic prefix. But this wastage of power is preferable over the advantage of providing an ISI free environment.

There are several advantages and disadvantages attached to the use for the cyclic prefix within OFDM.

Advantages

- ***Provides robustness:*** "The addition of the cyclic prefix adds robustness to the OFDM signal. The data that is retransmitted can be used if required".
- ***Reduces inter-symbol interference:*** "The guard interval introduced by the cyclic prefix enables the effects of inter-symbol interference to be reduced".

Disadvantages

- ***Reduces data capacity:*** "As the cyclic prefix re-transmits data that is already being transmitted, it takes up system capacity and reduces the overall data rate"

1.6 PEAK-TO-AVERAGE-POWER-RATIO (PAPR)

In a solitary transporter framework, a solitary blur causes the entire information stream to experience into the mutilation i.e known as the recurrence specific blurring. To beat the recurrence selectivity of the wideband channel experienced by single-bearer transmission, different transporters can be utilized for high rate information transmission. In multicarrier transmission, a solitary information stream is transmitted over various lower rate subcarriers. The figure 1.3 demonstrates the essential structure and idea of a multicarrier transmission framework

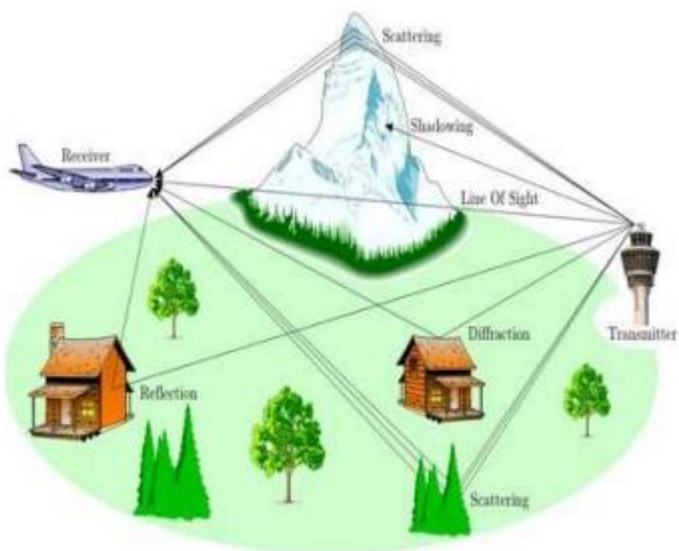


Figure 1.4 Multicarrier Modulation

Utilizing this multicarrier transmission the recurrence specific wideband channel can be approximated by different recurrence level narrowband channels. Give the wideband a chance to be partitioned into N narrowband subchannels, which have the subcarrier recurrence of fk, k = 0, 1, ..., N − 1. Symmetry among the subchannels ought to be kept up to stifle the ICI (Inter Carrier Interference) which prompts the distortionless transmission. So in this transmission conspire the distinctive images are transmitted with symmetrical subchannels in parallel shape. In the event that the oscillators are being utilized to create the subcarriers for each subchannel, the usage of this transmission conspire winds up complex. To maintain a strategic distance from this multifaceted nature one critical transmission plot comes into picture that is the OFDM (Orthogonal Frequency Division Multiplexing)

"Peak-to-average-power-ratio is defined as the ratio of peak power of the signal to the average power of the signal. For an OFDM signal x (t) PAPR can be expressed as":

$$PAPR = \frac{\max\ |x(t)|^2}{avg|x(t)|} \qquad (1.2)$$

For correspondence frameworks PAPR is essential since it identifies with the power devoured by the transmitter. High PAPR isn't alluring in light of the fact that when the high pinnacle flag is transmitted through a non-straight gadget, for example, high power enhancer (HPA) it causes out-of band radiations and in-band mutilation. High power flag requires vast contribution back-off and a corresponding yield back-off i.e. decreasing the normal intensity of the flag to transmit the flag. This lessens the effectiveness of the power intensifier and points of confinement battery life. PAPR is a vital parameter to be considered in outline of a down to earth correspondence framework. The significance of PAPR lies in the way that it gives data about the power devoured by the transmitter. As the power utilization in the transmitter will be high it will interest for higher cost and greater multifaceted nature. Consequently control utilization at the transmitter ought to be low which suggests that PAPR ought to be low.

1.7 DISADVANTAGES OF HIGH PAPR

High PAPR involves high worry in the plan of any correspondence framework. PAPR gives the information about the power productivity of the transmitter. In MIMO-OFDM as the quantity of subcarriers is high in this way it gives high PAPR which is an inconvenience of MIMO-OFDM framework. At the point when a powerful flag is transmitted through a non-straight gadget it causes high out of band radiations and in band twisting. High power flag requires substantial contribution back-off and a corresponding yield back-off i.e. diminishing the normal intensity of the flag to transmit the flag. This lessens the proficiency of the power intensifier and cutoff points battery life. For high PAPR flags high power intensifier is required which will build the power prerequisites and also the cost of the transmitter which isn't attractive. In addition, high PAPR likewise requests higher measure of determination for Digital to simple convertor (DAC) and simple to advanced convertor (ADC). High determination DAC and ADC builds the multifaceted nature of the framework regarding expense and power. Thus there is a need to lessen high PAPR. A few procedures have been proposed for the diminishment of high PAPR.

1.8 PAPR REDUCTION TECHNIQUES

Many PAPR reduction techniques have been proposed some of which are:

Selected Mapping (SLM)

Partial Transmit sequence (PTS)

Clipping

Companding

Among all these techniques we have used SLM for the implementation of our MIMO-OFDM system and reduction of PAPR. The disadvantage of SLM technique is that it requires the transmission of side information along with the information signal which reduces the data rate of the system and bandwidth efficiency is also reduced. Therefore, we have proposed a scheme which does not require additional transmission of side information. In this chapter we have discussed both the conventional SLM scheme and our proposed SLM scheme.

several methods have been developed to reduce PAPR since high PAPR is a matter of concern.

The various methods for reduction of PAPR are:

Clipping

"In this method the signal is clipped by some amount which reduces the peak power of the signal and hence PAPR. In this technique the maximum amplitude of the signal is reduced due to which the peak power of the signal is decreased which leads to reduction in the PAPR of the signal".

Companding

"In Companding scheme first the signal is compressed at the transmitter side to reduce the peak power and at the receiver side the signal is expanded to get back the original signal. As the signal is compressed at the receiver side so the expansion is also required at the receiver side to get back the original signal. This makes the system complex".

Selected Mapping (SLM)

"In this scheme the signal is split into several signals and then the signal with least PAPR is selected and transmitted. But in this technique the index of the signal having minimum PAPR is also to be transmitted along the transmit signal. Therefore, it requires more bandwidth".

Partial Transmit sequence (PTS)

"In this the signal is divided into different sub blocks and the signal with minimum PAPR among all the sub blocks is selected for transmission".

1.9 ADVANTAGES OF OFDM SYSTEM

The greatest preferred standpoint of OFDM is that it is resistant to intersymbol impedance (ISI). The ISI is caused due to the multipath defer spread caused in the channel. The OFDM framework is insusceptible to such multipath defer spread and along these lines it helps in destroying ISI. The intercarrier impedance (ICI) can likewise be expelled by utilizing OFDM frameworks.

Also, as in OFDM framework the higher recurrence channel is isolated into a few little recurrence groups it hence makes the channel level blurred rather than recurrence specific blurred. It makes the procedure of recurrence adjustment less demanding and the channel winds up safe to the issue of recurrence specific blurring.

Thirdly, as the tweak and demodulation is finished utilizing basic FFT and IFFT tasks along these lines this OFDM plot is anything but difficult to actualize.

Fourthly, OFDM framework gives higher information rates.

Fifthly, OFDM framework is resistant to multipath twisting or we can state that the multipath contortion is less in OFDM frameworks.

Lastly, also OFDM system offers the advantage of increased spectral efficiency.

1.10 DISADVANTAGES OF OFDM SYSTEM

The fundamental impediment of OFDM framework is that it has high PAPR. It is intricate as it is a multicarrier adjustment and not a solitary transporter tweak. On account of high PAPR it requires high power transmitter and high power transmitter more measure of linearity. Because of expansion of cyclic prefix it requires more transfer speed and more power. It is additionally more touchy to recurrence balance blunders.

- OFDM is delicate to Doppler move - recurrence mistakes balance the beneficiary and if not revised the symmetry between the transporters is corrupted.

- Sensitive to recurrence timing issues.

- Possesses a high top to normal power proportion - this requires the utilization of straight power intensifiers which are less proficient than non-direct ones and this outcomes in higher battery utilization.

- The cyclic prefix utilized causes a bringing down of the general phantom proficiency.

1.11 APPLICATIONS OF OFDM SYSTEM

Symmetrical recurrence division multiplexing (OFDM) transmission plot is a sort of multichannel framework which dodges the utilizations of the oscillators and bandlimited channels for each subchannel. The OFDM innovation was first conceptualized in the 1970s. The principle thought behind the OFDM is that since low-rate balances are less touchy to multipath, the better path is to send various low rate streams in parallel than sending one high rate waveform. It partitions the recurrence range into sub-groups sufficiently little with the goal that the channel impacts are consistent (level) over a given sub-band. At that point an established IQ (In stage Quadrature stage) tweak (BPSK, QPSK, M-QAM, and so forth) is sent over the sub-band. In the event that it composed effectively, all the quick changing impacts of the channel vanish as they are presently happening amid the transmission of a solitary image and are in this manner regarded as level blurring at the collector A substantial number of firmly dispersed symmetrical subcarriers are utilized to convey information. The information is partitioned into a few parallel information streams or channels, one for each subcarrier. Each subcarrier is regulated with a traditional tweak plan, for example, Quadrature Amplitude Modulation (QAM) or Phase Shift Keying (PSK) at a low image rate. The aggregate information rate is to be kept up like that of the traditional single transporter tweak conspire with a similar transmission capacity. Symmetrical Frequency Division Multiplexing (OFDM) is a promising strategy for accomplishing high information rate and battling multipath blurring in Wireless Communications. Symmetrical Frequency Division Multiplexing is an uncommon type of multicarrier adjustment which is especially suited for transmission over a dispersive channel. Here the diverse transporters are symmetrical to each other, that is, they are absolutely free of each other. This is accomplished by putting the bearer precisely at the nulls in the adjustment spectra of each different as appeared in figure 1.1.

"The orthogonality of the carriers means that each carrier has an integer number of cycles over a symbol period. Due to this integer number of cycles, the spectrum of each carrier has a null at the center frequency of each of the other carriers in the system that results in no interference between the carriers, allowing them to be spaced as close as possible. The problem of overhead carrier spacing required in Frequency Division Multiplexing (FDM) can be recovered. So this multicarrier transmission scheme allows the overlapping of the spectra of subcarriers for bandwidth efficiency".

"OFDM has been used for Digital Audio Broadcasting (DAB) and Digital Video Broadcasting (DVB) in Europe and for Asymmetric Digital Subscriber Line (ADSL) high data rate wired links. OFDM has also been standardized as the physical layer for the wireless networking standard, HIPERLAN2" in Europe and as the IEEE 802.11a, g standard in the US, promising raw data rates of between 6 and 54Mbps".

Examples of applications are:

- HDTV Wireless LAN Networks
- 5.3.1 HIPERLAN/2
- IEEE 802.11g
- IEEE 802.16 Broadband Wireless Access Systems
- Wireless ATM transmission system
- IEEE 802.11a

CHAPTER-02

OFDM SYSTEM MODEL

This section investigates the essential standards of OFDM and the primary focal points and downsides, where the high crest to-normal power proportion (PAPR) plays a critical roleThe radio wire decent variety is a system which battles the impact of recurrence particular multipath blurring channel. On the off chance that at the base station numerous radio wires are utilized and at the remote unit just a single recieving wire is utilized then i.e. called the transmit assorted variety. We can likewise call it as Multiple Input Single Output (MISO) case. This assorted variety procedure is extremely prudent. In the event that at the transmitter side we utilize single radio wire and at the beneficiary side different recieving wire then that will be known as recipient assorted variety or SIMO (Single Input Multi Output) framework. On the off chance that we utilize numerous recieving wires at both transmitter and beneficiary side then that will be known as MIMO (Multi Input Multi Output) framework. As we are utilizing OFDM system before transmitting the message through the radio wire thus it will be called as MIMO-OFDM Technique.

Here the use of Selected Mapping system has done on the transmit assorted variety case particularly for the instance of two transmitting radio wire and one accepting recieving wire (i.e. 2×1 MISO). So to transmit a flag from these two recieving wires we ought to need to take after some transmit decent variety procedure. Here the reproduction works are being broke down with considering a notable transmit decent variety plot i.e. known as the Alamouti coding plan. As indicated by this decent variety method there will be two encoding plans that to be utilized at the transmitter side, one is the Space Time Block Coding (STBC) conspire and the another is Space Frequency Block Coding (SFBC) plot demonstrated as follows. As per the thought in SLM the first information square will be changed over into a few free flags and the flag having most minimal PAPR will be transmitted. To get back the first information square it must be required to send side data as an arrangement of bits alongside the chose flag. The mistaken discovery of this side data will offer emerge to loss of the entire information square. So this is one of the burdens of SLM system. Another drawback of this method is its high unpredictability because of quality of a considerable measure of IFFT hinders before choosing a specific OFDM flag. Here a strategy being proposed to create an arbitrary framework from the current stage lattice of the traditional SLM method which fullfils the criteria that the new grid has less number of lines than that of the current network

The expanding require for high-piece rate advanced versatile interchanges has impelled the presence of Orthogonal Frequency-Division Multiplexing (OFDM) for accomplishing great execution in high rate information transmission. It is likewise a powerful strategy that delivers a high ghastly proficiency and a decent plan to battle recurrence specific blurring directs in remote correspondence frameworks without overlooking the real property that is subcarrier symmetry.

2.1 GENERAL PRINCIPAL

OFDM is a specific kind of FDM regulation. The first advance in the OFDM framework is to change over a serial information stream into a parallel stream and after that adjust the images, utilizing the quadrature sufficiency regulation (QAM) or the stage move keying (PSK) balance. The transmitter and recipient can be executed by methods for the IDFT and DFT individually. After the images are tweaked the information stream is changed over to recurrence area by methods for an IFFT. The length NFFT of the FFT capacity ought to be picked significantly bigger than the quantity of helpful subchannels N to guarantee that the edge impacts are unimportant at a large portion of the examining recurrence and to guarantee that the state of the recreation filter of the computerized to-simple converter (DAC) does not influence the significant part of the range. Figure 2.1 demonstrates the state of an OFDM range for N = 48 and N = 1536 subcarriers and how the side flaps rot more extreme as the quantity of subcarriers increments. At the recipient, a FFT of a similar length is performed and the N helpful coefficients will be removed from the NFFT ghastly coefficients. Figure demonstrates a square chart of an OFDM framework. The yield flag of the IFFT square is a discrete flag which is prepared by the DAC. This discrete flag has an intermittent range so the DAC needs to filter it by a low-pass filter keeping in mind the end goal to wipe out the superfluous reproductions. As said previously, these filters lessen the subcarriers near the Nyquist recurrence, so these subcarriers ought to be stayed away from for information transmission.

In the event that the transmission capacity of each subcarrier is considerably less than the channel intelligibility transfer speed, a recurrence level channel model can be expected for each subcarrier. In addition, embeddings a cyclic prefix (or watch interim) brings about a between image obstruction (ISI) free channel expecting that the length of the protect interim is more prominent than the defer spread of the channel. Hence, the impact of the multipath channel on each subcarrier can be spoken to by a solitary complex multiplier, influencing the plentifulness and period of each subcarrier. Thus, the equalizer at the collector can be executed by an arrangement of complex multipliers, one for each subcarrier.

The baseband OFDM framework is for all intents and purposes the same for every one of the plans of channel estimations and varies just from the coalition of the channel however a few plans can include another alliance utilized particularly for addition or for balance,… Then we will exhibit in this segment the real frameworks utilized by the lion's share of channel estimation plans.

The flag transfer speed is separated into N little subchannels and the recurrence of each subcarrier is shaped a symmetrical arrangement of frequencies, which are known at the collector. This structure with different subchannels makes OFDM appropriate for multiuser correspondences, dispensing a few subcarriers to every client. Enabling the subcarriers to cover lessens the required data transfer capacity and builds the otherworldly efficiency. The OFDM adjusted flag can be communicated as

$$x(t) = \sum_{n=0}^{N-1} X_n e^{j2\pi f_n t} \qquad (0 < t < T_s)$$

Where T_s is the duration of an OFDM symbol, 1 Ts is the distance between subcarriers (or subchannel space) in frequency domain (Δf) and Sn a block of N data complex symbols chosen from a signal constellation like QAM or PSK. Each subcarrier is located at

$$f_n = \frac{n}{T_s} \qquad (0 < n < N - 1)$$

In order to maintain the orthogonality between the OFDM symbols, the symbol duration and subchannel space must meet the condition TsΔf = 1. When x(t) is sampled every Ts N

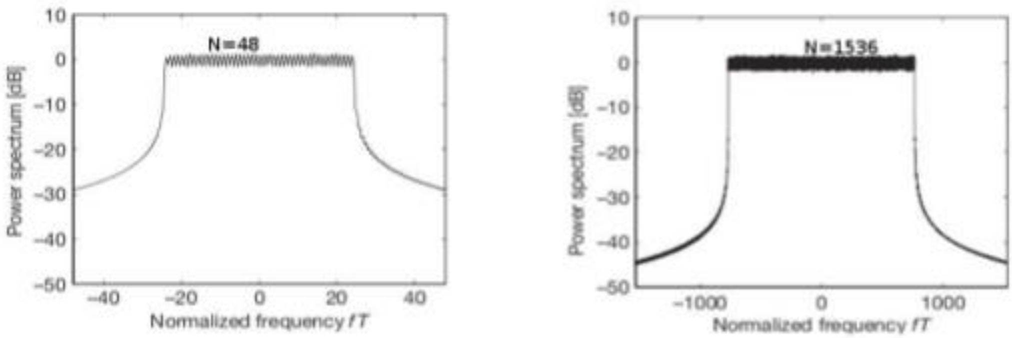


Figure 2.1 OFDM spectrum of N Subcarrier

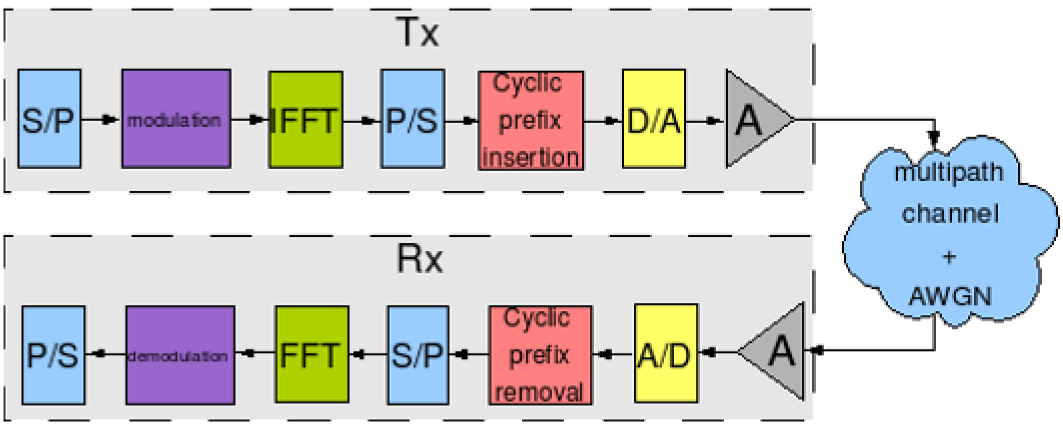


Figure 2.2 : Block Diagram of OFDM System

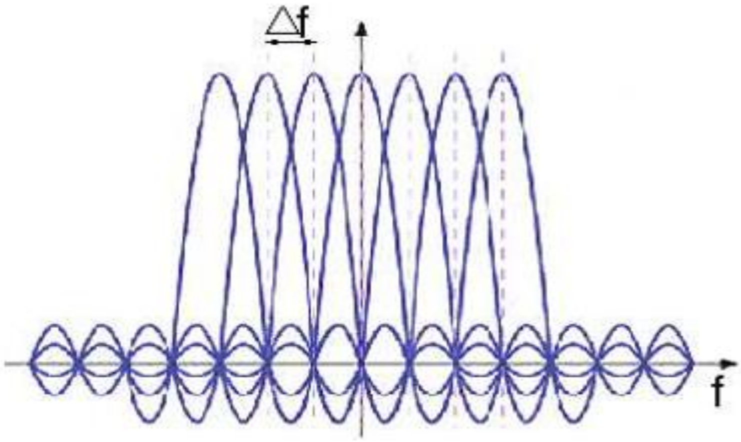


Figure 2.3 OFDM signal in frequency domain

the mathematical expression of the sampled signal is

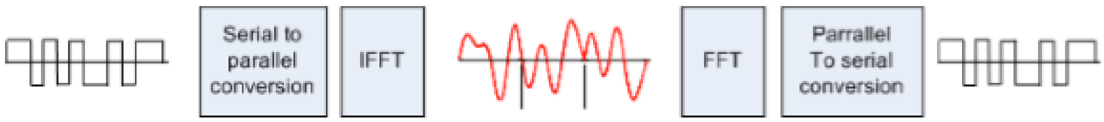
$$x_k = x(kT_s) = \sum_{n=0}^{N-1} X_n e^{j2\pi f_n \frac{kn}{N}}$$

Setting $f_0 = 0\ then\ f_n Ts$=k and x_k becomes

$$x_k = \sum_{n=0}^{N-1} S_n e^{j2\pi f_n \frac{kn}{N}} = IDFTS_n$$

The aggregate transfer speed of the OFDM flag is B = N·Δf. Figure 2.3 demonstrates the OFDM premise capacities and how they symmetrically cover. At the inside recurrence of each subcarrier all the rest are zero, so they don't meddle with each other since the collector ascertains the range esteems at the pinnacle purpose of each subcarrier; thusly intercarrier obstruction (ICI) is kept away from which is an imperative preferred standpoint of OFDM frameworks

On the off chance that more subcarriers are included into the transmission capacity utilized by the OFDM flag, at that point the separation between subcarriers Δf will diminish which in time space implies that the length of an image Ts increments. In recurrence area, Δf is normally substantially littler than the aggregate accessible transmission capacity, making recurrence synchronization more difficult. Having more opportunity for every image will expand the likelihood of accepting it effectively since there is some transient before the image is accurately set; if the image term is too short, it might happen that there is no time after the transient to peruse the image thus there is a high likelihood of translating it off-base. The OFDM image ought to be substantial contrasted with the motivation reaction of the channel τmax. In any case, the OFDM image must be sufficiently short so the fleeting varieties because of developments of the transmitter as well as the collector don't bring about a period shifting channel inside the OFDM image. Since the length of the OFDM image increments directly with the quantity of subcarriers, the quantity of subcarriers (and the span of the OFDM image) are restricted by the lucidness time of the channel.



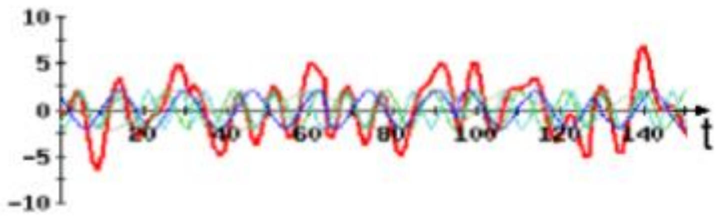


Figure 2.4 OFDM signal in Time Domain

“Because of the frequency selective fading properties of wireless channels, some of the subcarriers of the OFDM signal are enhanced and others suffer fading. If N is large enough, each subcarrier is narrow compared to the coherence bandwidth of the channel and even under severe fading conditions they suffer flat fading”.

“Multipath delay causes ISI between OFDM symbols, which occurs when an OFDM symbol is distorted by the previous one. A simple solution to this problem is transmitting a guard interval before each OFDM symbol. A cyclically extended guard interval is added to the OFDM symbol so that it is preceded by the last Ng IFFT coefficients of itself. The total symbol duration now is $T_{total} = T_s + T_g$, where T_g is the guard interval duration and T_s is the useful symbol duration. The duration of the guard interval depends on the application, usually, since the insertion of the guard interval reduces the data throughput, Tg is chosen so that Tg < Ts/4. The guard interval absorbs time synchronization errors as well as the echoes from the delayed signals".

Time synchronization can without much of a stretch be accomplished by presenting a period stamp, such as rehashing intermittently a specific known OFDM reference image of known substance. Typically time synchronization utilizes preparing successions which are presented in the OFDM stream. At times time synchronization utilizes the cyclic prefix of the OFDM images since it is an occasional grouping and can be utilized to appraise the stage changes endured by each OFDM image. Recurrence synchronization is imperative so as to keep the symmetry amongst subcarriers and to manage stage turns at the got images, this is particularly vital in frameworks that utilization differential tweaks.

Despite the fact that the flag is worked in recurrence area, the information transmission happens in time space. Subsequent to forming the flag, the IFFT square changes over it to time space and creates N yield tests, comparing to the N subcarrier of the OFDM framework and which make a solitary OFDM image, be that as it may, as said previously, not all the N subcarrier convey information. The subsequent flag is the total of all the adjusted subcarriers which shape the baseband flag. Figure 2.4 shows how an OFDM flag looks like in time space.

The diverse subcarriers (blue and green waves) in Figure 2.4 are indicated frame the OFDM flag (red wave). The state of the red wave has a few pinnacles significantly more noteworthy than the normal power. At the point when all the subcarriers are included valuably, the subsequent power is substantially higher than the normal intensity of the OFDM flag. This causes a huge pinnacle which increments as the quantity of subcarriers builds, prompting a high PAPR . High PAPR is a vital disadvantage of OFDM frameworks.

Initially the primary points of interest:

• high ghastly efficiency. The flag is worked in recurrence space so it can be formed keeping in mind the end goal to utilize the accessible transmission capacity as efficiently as would be prudent.

• efficient in multipath situations. OFDM expands the image length by N, being N the quantity of subcarriers and this together with the cyclic prefix can totally wipe out ISI. Since the transmission capacity of each subcarrier is thin contrasted with the intelligence data transmission of the channel, blurring can be considered as flat which decreases the multifaceted nature of the recipient.

• basic advanced acknowledgment by utilizing the FFT activity. On account of the advances in computerized flag handling and VLSI, the acknowledgment of the FFT activities is currently easy to actualize.

• low complex recipients because of evasion of ICI and ISI. Each sub-channel can be considered independently since ICI does not influence the flag and each channel endures flat blurring so perplexing equalizers can be stayed away from.

• distinctive regulation plans can be utilized on singular sub-bearers. Along these lines more strong balances can be utilized at the subcarriers that endure all the more blurring, if channel estimation is utilized.

What's more, the Main Drawbacks are:

• exact recurrence and time synchronization is required

• more delicate to Doppler spreads than single-bearer plans

• touchy to recurrence counterbalance and stage commotion caused by defects in the transmitter and the collector oscillators

• watch interim causes misfortune in phantom efficiency

• high PAPR

CHAPTER-3

PROBLEM IDENTIFICATION

3.1 PAPR

A non-consistent envelope with high pinnacles is a fundamental burden of Orthogonal Frequency Division Multiplexing (OFDM). These high pinnacles deliver flag journeys into non-straight locale of activity of the Power Amplifier (PA) at the transmitter, accordingly prompting non-direct bends and unearthly spreading. Numerous Peak to Average Power Ration (PAPR) diminishments strategies have been proposed in the writing. The goal of this survey is to give a reasonable comprehension of various strategies to decrease PAPR of the flag.

Down to earth correspondence frameworks are generally crest control constrained. An OFDM flag comprises of countless adjusted subcarriers, which on cognizant expansion may create a high momentary top as for the normal flag level. High power intensifiers (HPA's) are utilized to open up the time area OFDM flag to the coveted power level. To manage the expansive variances in the envelope of OFDM flag, HPA's are required to have an extensive direct range. Such HPA's are exorbitant, cumbersome and hard to outline. In the event that a HPA with constrained direct range is used for intensification, it might work close immersion and can cause out-of-band (OOB) radiations and in-band contortion. The OOB mutilation/clamor is a noteworthy concern, particularly in remote interchanges, where huge contrasts in flag quality from a versatile transmitter force stringent prerequisites on nearby channel obstruction (ACI). To suit expansive envelope vacillations of the OFDM flag, the advanced to simple converter (DAC) and simple to computerized converter (ADC) are additionally required to have a wide powerful range, which additionally builds the cost and multifaceted nature of the OFDM framework. The ongoing enthusiasm for the use of OFDM to present and cutting edge remote correspondence systems has set off the improvement of various plans to battle this issue. Likewise, OFDM framework requires tight recurrence synchronization in contrast with single transporter frameworks, in light of the fact that in OFDM, the subcarriers are narrowband. In this way, it is touchy to little recurrence counterbalance between the transmitted and the got flag, which may emerge because of Doppler Effect in the channel, or because of befuddle amongst transmitter and recipient nearby oscillator frequencies. This transporter recurrence balance (CFO) irritates the symmetry of the subcarriers and the flag on a specific subcarrier won't stay free of the rest of the subcarriers. This wonder, known as between bearer impedance (ICI), is another test in the mistake free demodulation and discovery of OFDM images.

The PAPR is the connection between the most extreme intensity of an example in a given OFCDM communicate image partitioned by the normal intensity of that OFCDM image. PAPR happens in a multicarrier framework when the diverse sub-bearers are out of stage with each other. The info image stream of the IFFT ought to have a uniform power range, however the yield of the IFFT may bring about a non uniform or pointed power range. The greater part of transmission vitality would be designated for a couple rather than the larger part subcarriers. This issue can be evaluated as the PAPR measure. It causes loads of issues in the OFCDM framework at the transmitting end. Likewise transistor function as an enhancer in direct mode yet when crest deviation about normal is altogether high and the flag level moves into non straight locale, a speaker yield gets mutilated and we won't get devoted intensification. Subsequently high estimation of PAPR in OFCDM framework brings about, enhancer goes in non-direct district. Therefore OFCDM misfortunes its symmetry which prompts Inter Carrier Interference(ICI) in the framework and entomb image interference(ISI) that is more extreme than due to pre image impedance of OFCDM.PAPR is tricky on the grounds that there is no such intensifiers or advanced to simple converters (DAC/ADC) which have extensive variety of linearity. so because of constraint of linearity of speakers and converters, one approach to battle PAPR is control back - off, in which if control surpasses to linearity scope of intensifiers/converters then it back - off by limiter circuit and keep up it in straight scope of the gadget . Another approach to lessen PAPR is to expand the linearity scope of speakers/converters however it is exceptionally thorough to outline and expensive as well.

SLM crest control diminishment is distortion less as it chooses the real transmit motion from an arrangement of elective signs, which all speak to a similar data. The particular flag age data should be transmitted and deliberately secured against bit mistakes. Marco

Breiling et al (2001) propose an augmentation of SLM, which utilizes scrambling and ceases from the utilization of express side data by a mark inclusion and scrambling approach where just little repetition should be brought into the flag. The transmit flag measurements and the phantom properties in nearness of 39 transmitter nonlinearities are conclusively enhanced with the end goal that a sparing of 1 to 2 dB in back off can without much of a stretch be accomplished.

Houshou Chen and Hsinying Liang (2007) researched with BPSK subcarriers by consolidating SLM and twofold cyclic codes. The creator decays the paired cyclic codes into coordinate entirety of two cyclic sub codes: the revision sub code utilized for blunder amendment and the scrambling sub code for PAPR diminishment. The transmitted OFDM flag is chosen that accomplishes least PAPR, from the arrangement of parallel cyclic code words. The got flag can be effortlessly decoded without the need of any side data. Reenactments demonstrate that the proposed plot with simplex code as scrambling sub code accomplishes great PAPR diminishment.

At the point when in time space all the N subcarriers are included usefully, they create a pinnacle control that is N times more noteworthy than the normal intensity of the flag. The PAPR is figured by the accompanying condition

$$PAPR = \frac{max|x(n)|^2}{E[|x(n)|^2]}$$

Where x(t) is the amplitude of the signal.

“The peak power of the OFDM signal, regarding the worst case when all the subcarriers are added-up constructively, is the sum of all the N subcarriers: 1·N = N. The mean power”

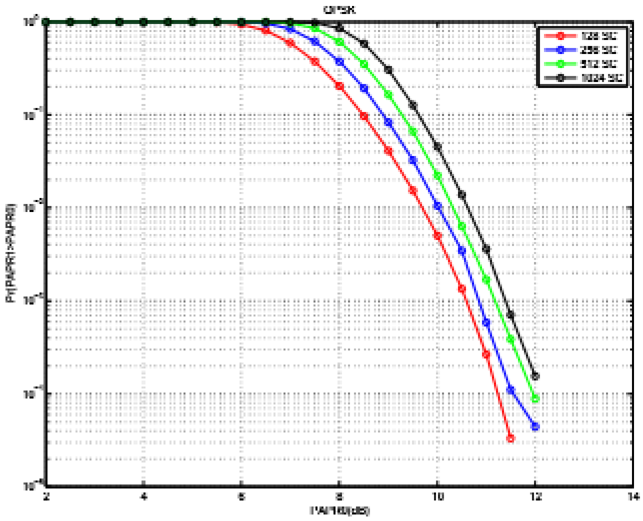


Figure 3.1 CCDF for different number of subcarrier

“of the OFDM signal is the sum of all the values of the signal, which is actually N, divided by the total number of subcarriers, which is also N. Therefore, the maximum PAPR is”

$$PAPR_m = \frac{N}{\frac{N}{N}} = N$$

This maximum PAPR increases whenever the number of subcarriers increases. Thus, if N ⟶ ∞ ⇒ x_k becomes Gaussian distributed, for k = 1,..,N, which means that

$$P(x_k < PAPR_m) < 1$$

When the number of subcarriers tends to ∞ this probability gives

$$\frac{lim}{n \to \infty} \prod_{k=1}^{N} P(x_k < PAPR_m) = 0$$

If the above statement represents the probability of a signal x_k to have a smaller PAPR than the given one PAPR, the probability of the signal to have a PAPR greater than PAPR is

$$\frac{lim}{n \to \infty} \left(1 - \prod_{k=1}^{N} P(x_k < PAPR_m)\right) = 1$$

The above articulation can be better seen graphically in Figure 2.5, which demonstrates the corresponding combined dissemination work (CCDF) of an OFDM flag. The CCDF means the likelihood of a flag to have a higher PAPR than an edge PAPRm, so in the figure, even and vertical tomahawks speak to the edge estimations of PAPR and the CCDF separately. The CCDF reenactment contrasts the CCDF of signs and diverse number of subcarriers (from 128 to 1024) and it authenticates the hypothesis. For all the diverse signs of the reenactment, the likelihood of having higher PAPR than a fixed PAPRm diminishes as this fixed esteem increments. Be that as it may, this likelihood increments as the quantity of subcarriers increments, and if N continues expanding the likelihood has a tendency to be 1 for any PAPRm so the

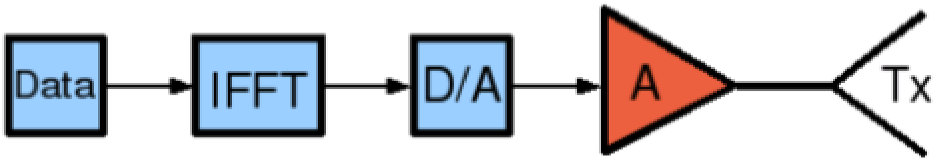


Figure 3.2 OFDM Transmitter basic scheme

PAPR of the flag when $N \rightarrow \infty$ will dependably be more noteworthy than PAPRm. The likelihood of having a pinnacle higher than PAPRm, however, diminishes as N increments in light of the fact that the more subcarriers there are, the less plausible it is that all them include usefully in the meantime, yet at the same time it might happen

In a few applications, the downsides of high PAPR defeat the benefits of OFDM. To see how and where the PAPR of the flag turns into an issue, it is important to investigate the OFDM transmitter, Figure 2.6 demonstrates an essential plan. The data information is produced and molded in the Data obstruct, this happens in recurrence area, at that point comes the IFFT square and the flag is a short time later in computerized time space. To send the flag through the reception apparatus, it must be first changed over to simple time area by methods for an A/D converter and afterward amplified with a RF control amplifier. After the RF amplifier comes the radio wire which sends the flag to the OFDM collector over the remote channel.

Investigating the RF amplifier, really into its trademark bend (Figure 2.6), it plainly indicates two working areas, the straight and the immersion ones. The bend in Figure 2.7 is given by the accompanying condition

$$F[x] = \frac{x}{(1+(x)^{2p})^{\frac{1}{2p}}}$$

“When the amplifier operates in the linear region, as its name indicates, signals are linearly amplified by the same factor A. However, when it operates in the saturation region, signals are not amplified anymore, they are flattened at the maximum output power of the amplifier. In this application (the OFDM transmitter), the system needs the amplifier to work in the linear region in order not to distort the data, the better performance will be achieved for an input back off (IBO) = 0 db. The IBO is defined as”

$$IBO = 10 \cdot \log_{10}(\frac{P_{max}}{P_{av,in}})$$

also, gives the proportion between the info control and the most extreme information intensity of the straight area so an IBO= 0 dB implies that the amplifier is working at the maximum furthest reaches of the direct district. The issue shows up when the pinnacles of the OFDM flag are too extensive and don't fit in the straight locale. For this situation they are dealt with by the immersion locale thus they are non-directly modified, causing intermodulation among subcarriers and out-of-band radiation. To have the capacity to hold these pinnacles, the operational amplifier (OA) of the transmitter needs an expansive powerful range. Expanding the direct area of an OA (expanding p in condition 2.10) is exceptionally costly and it is inefficient for this situation. In the event that N builds, the pinnacle power will likewise increment thus will do the PAPR. On the off chance that N is sufficiently extensive, the real OA won't have the capacity to hold the new pinnacle power and it is important to supplant it. Plus, the bigger the OA's dynamic range is, the more battery it expends and since most OFDM frameworks are

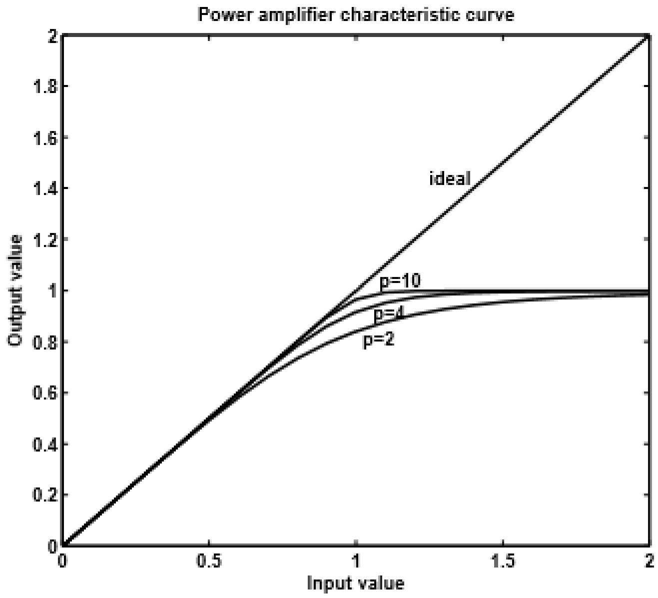


Figure: 3.3 Nonlinear Amplifier Characteristics

likewise, gives the extent between the data control and the most extraordinary data power of the straight region so an IBO= 0 dB infers that the amplifier is working at the greatest farthest reaches of the immediate locale. The issue shows up when the zeniths of the OFDM hail are excessively broad and don't fit in the straight area. For this circumstance they are managed by the drenching area in this way they are non-specifically modified, causing intermodulation among subcarriers and out-of-band radiation. To have the ability to hold these zeniths, the operational amplifier (OA) of the transmitter needs a far reaching ground-breaking range. Growing the immediate region of an OA (extending p in condition 2.10) is uncommonly expensive and it is inefficient for this circumstance. If N assembles, the zenith power will in like manner augment along these lines will do the PAPR. If N is adequately broad, the genuine OA won't have the ability to hold the new apex power and it is essential to supplant it. In addition, the greater the OA's dynamic range is, the more battery it uses and since most OFDM systems are

The basic idea behind coding technique is “to select those codeword that reduce the PAPR for transmission. A forward error correction (FEC) code is defined by (n,k), where n are the data bits and k represents redundant bits, so the idea is to add redundant bit in a manner that overall PAPR value is minimized. FEC are classified as block codes and run length codes. In block codes, a block of data bits are used together to encode them whereas run length codes employs memory and lower values of n. Linear block codes, Golay complementary codes, Reed Mullar, Bose Chaudhari Hochquenghem (BCH), low density parity check (LDPC) are few block codes which have been used for PAPR reduction. Turbo codes which are derived from convolution codes are also discussed in literature for PAPR reduction".

CHAPTER-04

PAPR REDUCTION METHODOLOGY

This part investigates a portion of the methods used to lessen high PAPR in OFDM frameworks. Proposed work speaks to a proficient strategy to lessen high PAPR of the OFCDM flag. The new model joins the highlights of DCT network change procedure and the other SLM strategy to create assist decrease in the PAPR of the flag than they perform separately. A non-successive code task plot was presented. The novel recognition strategy for the OFCDM, called half and half multi code impedance retraction and least mean square blunder identification. Rapid information transmission is required in future remote frameworks, particularly in the downlink. OFCDM has turned into an extremely appealing remote access strategy for future 4G portable correspondences because of its prevalence over OFDM. OFCDM method has indicated promising outcomes in accomplishing a high information rate while at the same time fighting multipath blurring. OFCDM is a mix of symmetrical recurrence division multiplexing and two-dimensional (2D) spreading. 2D spreading accomplishes assorted variety picks up in both time and recurrence spaces. The present OFCDM frameworks utilize 1D symmetrical variable spreading factor (OVSF) codes to accomplish the required 2D spreading in code multiplexed channels. Be that as it may, 2D OVSF codes have better connection properties in contrast with 1D OVSF codes.

We present DCT SLM symmetrical recurrence coded division multiplexing (OFCDM) conspire for lessening of top to normal power proportion. There is a period for rapid information transmission in versatile correspondences. OFDM is exceptionally encouraging system for 4G standard like LTE (Long Term Evolution) and WIMAX (Worldwide Inter-operability for Microwave Access) yet in addition has a few issues like recurrence balance and PAPR (top to-normal power proportion). High top to-normal power proportion (PAPR) of the transmitted flag begins from the superposition of numerous autonomous sub bearers. In this paper, a Discrete Cosine Transform based altered specific mapping procedure is proposed to diminish the PAPR of the transmitted flag. This technique joins Discrete Cosine Transform (DCT) with changed Selective Level Mapping (SLM), the variation of SLM make utilization of the standard cluster of direct square codes. The proposed strategy can be acknowledged in two different ways plot 1 and 2. In scheme1 DCT is utilized before the IFFT obstruct in Modified SLM and in conspire 2 DCT is utilized after the Modified SLM square. Recreation comes about demonstrates that Scheme 1 is having preferable decrease execution over the plan 2. Because of PAPR diminishment ICI and ISI both lessens definitely.

Future 4G frameworks require transmission of more extravagant mixed media administrations which unquestionably suggest an expansion in information rate. The 4G frameworks will bolster interactive media administrations like rapid Internet access and communicate administrations from data locales. OFDM is a multicarrier transmission plot where client information is spread in time and recurrence heading before it is transmitted on numerous sub-transporters utilizing OFDM transmission Orthogonal recurrence and code division multiplexing is an exceptionally appealing method for rapid information transmission in versatile interchanges because of different points of interest, for example, high phantom productivity, heartiness to channel blurring, invulnerability to motivation obstruction, and ability of dealing with extremely solid multi-way blurring and recurrence specific blurring without providing great channel leveling

The primary thought of the proposed plot is to utilize a blend of two techniques. One is the DCT grid change strategy and SLM system. The plan to utilize the DCT change is to diminish the autocorrelation of the info arrangement which additionally lessens the crest to normal power issue and it likewise requires no side data to be transmitted to the beneficiary. In spite of the fact that SLM framework can get better PAPR by adjusting the OFDM motion without mutilation, its many-sided quality is high. DCT SLM is an effective PAPR decrease method in light of joint SLM and DCT network change is proposed. The principle thought of the DCT SLM is to utilize a mix of two suitable strategies. One is the DCT network change strategy and the other is the SLM procedure.

Consolidating OFDM with two-dimensional spreading (time and recurrence area spreading), a symmetrical recurrence and code-division multiplexing (OFCDM) framework has been proposed for the downlink correspondence in future 4G systems. In light of OFDM, OFDM gives all preferences of OFDM, as well as additional advantages by methods for 2D spreading. For instance, recurrence assorted variety pick up can be accomplished through recurrence area de-spreading because of the distinctive blurring experienced by subcarriers in a broadband channel. Moreover, with the presentation of time space spreading, the framework can give adaptable telecom rates. Like OFDM promptly bolsters MIMO recieving wire strategies.

M with two-dimensional spreading (time and frequency domain spreading), an orthogonal frequency and code-division multiplexing (OFCDM) system has been proposed for the downlink communication in future 4G networks. Based on OFDM, OFDM provides not only all advantages of OFDM, but also extra benefits by means of 2D spreading. For example, frequency diversity gain can be achieved through frequency domain de-spreading due to the different fading experienced by subcarriers in a broadband channel. Furthermore, with the introduction of time domain spreading, the system can provide flexible broadcasting rates. Similar to OFDM readily supports MIMO antenna techniques.

4.1 PAPR REDUCTION: SLM

This is a viable and mutilation less system utilized for the PAPR lessening in OFDM. The name of this method demonstrates that one arrangement must be chosen out of various groupings. As per the idea of discrete time OFDM transmission we should influence an information to square considering N number of images from the heavenly body plot. Where N is the quantity of subcarriers to be utilized. At that point utilizing that information square U number of autonomous applicant vectors are to be created with the duplication of free stage vectors. Give us a chance to consider X is the information obstruct with X (k) as the mapped sub image (i.e. the image from the heavenly body). Where $k = \{0, 1, 2, ...N - 1\}$. Give the u th a chance to stage vector is meant as B(u), where $u = \{1, 2, ...U\}$. The u th competitor vector that is created by the increase of information obstruct with the stage vector is indicated as X(u).

So, we can write the equation to get the k th element of u th candidate vector as

$$X^{(u)}(k) = x(k)B^{u}(k)$$

The transmitter, the transmitter of the OFDM maps the information bit stream into a symbol sequence, symbol sequence is converted by serial/parallel device, forming multiple parallel low sub-symbol streams, symbol streams are modulated by different subcarriers. After series/parallel conversion of the high-speed data streams, the symbol rate is greatly reduced, and the symbol period is relatively expanded, which can effectively resist the intersymbol interference. Unlike traditional multicarrier modulation techniques, multiple orthogonal subcarriers of OFDM can overlap each other so that the spectrum is fully utilized. The tail of each OFDM symbol is copied to the front of the symbol as a protection interval, which can eliminate interfere between OFDM symbols, and can also improve subcarrier scrambling. In an OFDM block, the input data can be expressed as: OFDM modulation signal can be expressed as:

In OFDM systems, as shown in fig.1, a fixed number of successive input data samples are modulated first (e.g., Quadrature Phase Shift Keying), and then combined together using IFFT at the transmitter side. IFFT is used to produce orthogonal data subcarriers. Let data block of length N be represented by a vector

$$X = [X_0, X_1, \ldots\ldots, X_{N-1}]^T$$

Duration of any symbol X_K. in the set X is T and represents one of the sub-carriers set the complex data block for the OFDM signal to be transmitted is given by

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_N e^{j2\pi n\Delta f t} \qquad 0 \leq t \leq NT$$

Where j=√−1, Δf is the subcarrier spacing and NT denotes the useful data block period

The use of a large number of subcarriers introduces a high PAPR in OFDM systems.[10] PAPR can be defined as the relationship between the maximum power of a sample in a transmit OFDM symbol and its average power. Coherent addition of N signals of same phase produces a peak which is N times the average signal. PAPR can vary up to its theoretically maximum of 10(dB), where N is the number of subcarriers.

$$PAPR = \frac{max|x(n)|^2}{E[|x(n)|^2]}$$

Where |x(n)|is the magnitude of x(n) and E[.] denotes the expectation operation

PAs at the transmitter are driven into saturation due to high PAPR, degrading the BER performance. To avoid driving the PA into saturation, the average power of the signal may be reduced. However, this reduces the SNR and, consequently, the BER performance. Therefore, it is preferable to solve the problem of high PAPR by reducing the peak power of the signal. Many PAPR reduction techniques have been proposed. The performance of a PAPR reduction scheme is usually demonstrated by two main factors: the complementary cumulative distributive function (CCDF) and bit error rate (BER)

Selective mapping (SLM) is a simple approach to reduce PAPR[12]. In this method, a set of sufficient different OFDM symbols $x_m, 0 \leq m \leq M - 1$are generated, each of length N, all representing the same information as that of the original OFDM symbol x, then the one with the least PAPR is transmitted. Mathematically, the transmitted OFDM symbol.

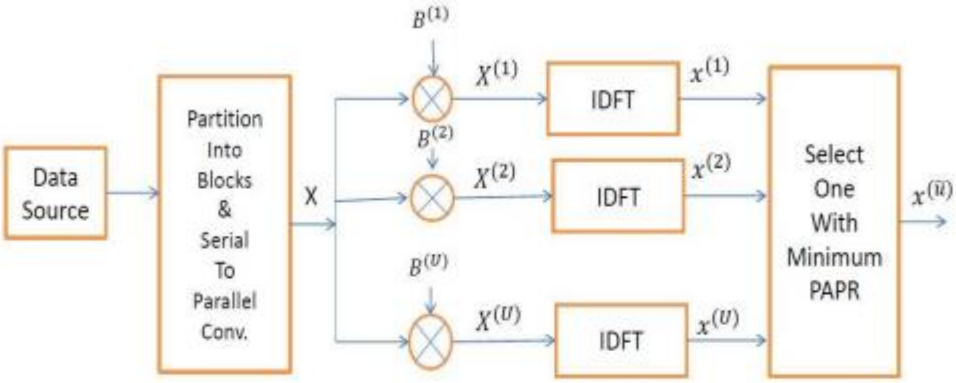


Figure:3.1 Block Diagram of SLM

The figure 3.1.1 provides description about the transmitter side of the SLM technique. This selected OFDM signal at transmitter side has to be detected at the receiver. So, the receiver must have the information about the perfect phase phase vector that has been multiplied to generate that selected OFDM signal. Hence to fulfil the requirement of the receiver some side information(SI) has to be transmitted along with the selected OFDM signal. This SI index is generally transmitted as a set of ⌈log2 U⌉ bits. For the efficient transmission of these extra bits channel coding technique should be required. If any SI index cannot be detected perfectly then that total recovered transmitted block will be in error. So, we should follow a new SLM technique which avoids the sending of SI index. This technique is discussed briefly in the following sections

Selective mapping (SLM) is a simple approach to reduce PAPR. In this method, a set of sufficient different OFDM symbols $x_m, 0 \leq m \leq M - 1$are generated, each of length N, all representing the same information as that of the original OFDM symbol x, then the one with the least PAPR is transmitted. Mathematically, the transmitted OFDM symbol.

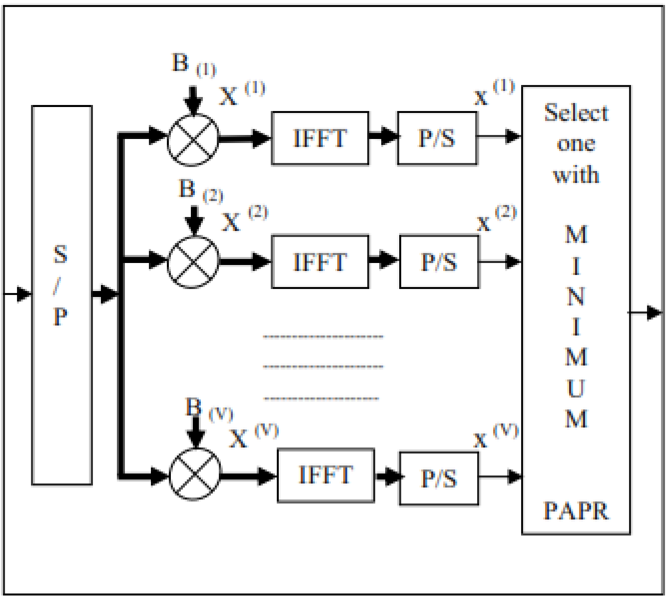


Figure 3.2 Block Diagram of SLM Based OFDM System

Figure 3.2 represents a block diagram of the SLM-OFDM system. Every data block is multiplied by V dissimilar phase sequences, each of length equal to N, $B^{(v)} = [b_{v,0}, b_{v,1}, \ldots\ldots, b_{v,N-1}]^T$ (v=1,2, 3,…V)which results in the changed data blocks. Now suppose the altered data block for the vth phase sequence is given by $X^{(v)} = [X_0 b_{v,0}, X_1 b_{v,1}, \ldots\ldots, X_{N-1} b_{v,N-1}]^T$. Each (v=1,2,…V) can be defined as

$$X_n^v = X_n b_{v,n} \qquad (1 \leq v \leq V)$$

After applying SLM to X, the OFDM signal becomes as

$$x_n^v = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k^v e^{j2\pi\left(\frac{n}{N}\right)k} \qquad n = 0,1, \ldots\ldots N-1\ , v = 1..V$$

The PAPR of OFDM signal can be written as

$$PAPR = \frac{max|x_n^v|^2}{E[|x_n^v|^2]}$$

Amongst the tailored data blocks X^v, v = 1, 2… V, the data block with the least PAPR is chooses for transmission and as a side information the information about selected phase sequence must be sanded to the receiver. At the receiving end, the operation is performed in the reverse order to recover the actual data block.

4.2 CALCULATION OF PAPR USING CCDF

As discussed above the analysis of the performance of PAPR reduction is very easy through the CCDF. This performance using the classical SLM technique is shown in figure 2.2. If we consider all the candidate vectors in a matrix form then without following the oversampling concept the dimension of that matrix will be U × N and with following the oversampling concept the dimension becomes U × V N. Here the number of subcarriers used to be N = 128 and the oversampling factor V = 4.

So, this figure 3.3 describes the performance criteria of the classical SLM technique on the basis of PAPR reduction performance. Another PAPR analysis also being

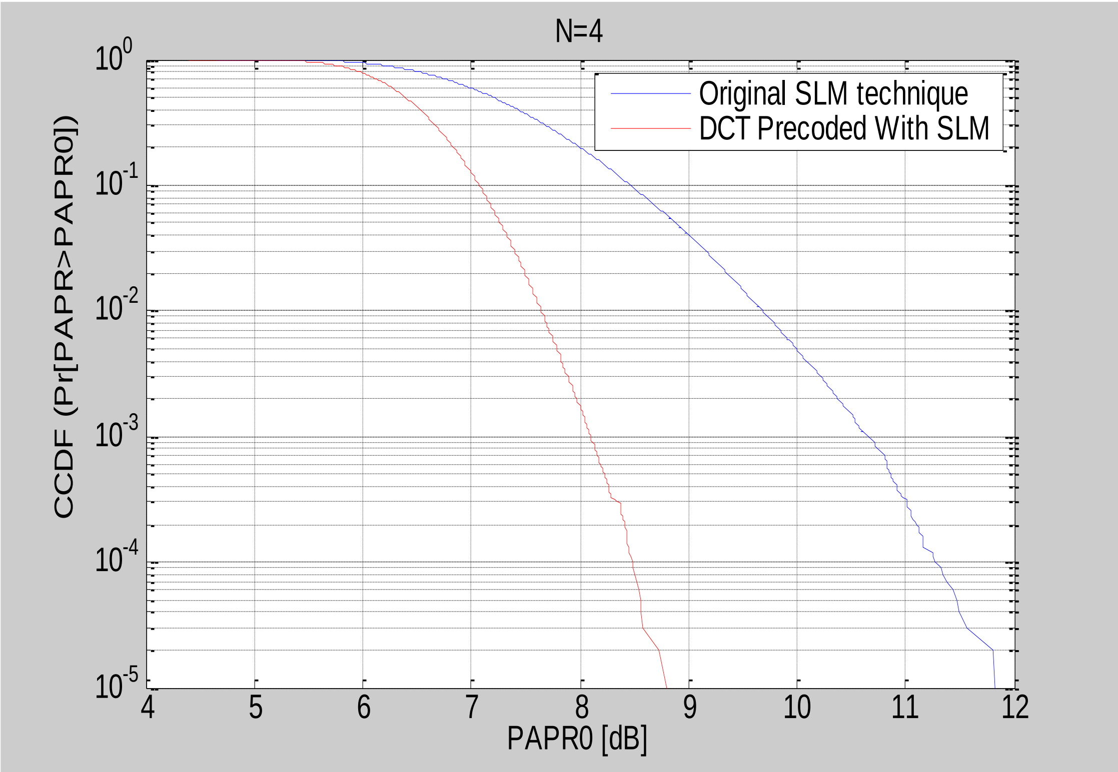


Figure:3.3 PAPR Compression for classical SLM and DCT SLM

Multicarrier transmission such as OFDM is one of the most attractive techniques for both wired and wireless applications due to its high data rates, robustness to multipath fading and spectral efficiency. However, it has a major drawback of generating high peakto-average ratio. Lots of PAPR reduction techniques are proposed in literature and discussed in this thesis.

CHAPTER-05

PROPOSED TECHNIQUE

5.1 DCT PRECODED OFDM SYSTEM

Instead of using complex exponential functions, cosinusoidal functions can be used as orthogonal basis to implement multi-carrier scheme. This can be synthesized using discrete cosine transform (DCT). For fast implementation algorithms DCT can provide fewer computational steps than FFT based OFDM. The effect of carrier frequency offset (CFO) will introduce inter-carrier-interference (ICI) in both the DFT-OFDM and DCT-OFDM

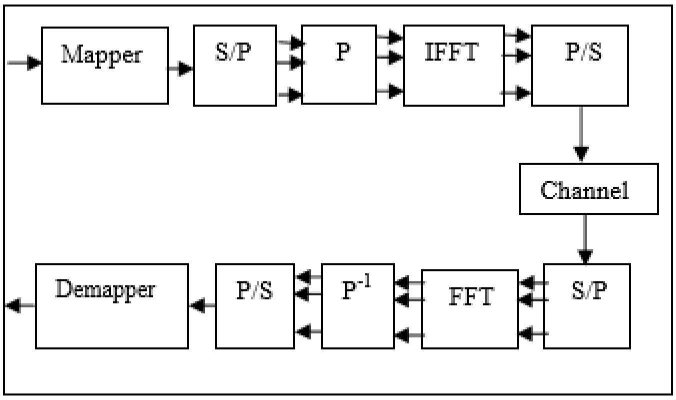


Figure 5.1 Block Diagram of Precoding Based OFDM System

Fig.5.1 shows a precoding based OFDM system. In this system a precoding matrix P of dimension N x N is constructed which is based on DCT. P is applied to constellations symbols before IFFT to reduce the PAPR. DCT matrix P of size N-by-N can be created by using equation

$$D_{i,j} = \begin{cases} \frac{1}{\sqrt{N}} & i = 0 \quad 0 \le j \le N-1 \\ \sqrt{\frac{2}{N}} & \quad 0 \le j \le N-1 \end{cases}$$

and DCT can be defined as

$$X(K) = \sum_{n=0}^{N \cdot 1} Cos\left[\frac{\pi}{N}\left(n + \frac{1}{2}\right)k\right]$$

where $K = 0,1 \ldots \ldots N-1$ In precoding based OFDM system baseband modulated data is passed through S/P convertor which generates a complex vector of size N that can be written as. Then precoding is applied to this complex vector which transforms this complex vector into new vector of length that can be written as Y=PX= $[Y_0, Y_1, \ldots\ldots, Y_{N-1}]^T$, Where P is a DCT based precoding Matrix of size M = N×N With the use of reordering as given in equation.

$$K = mN + n$$

matrix P can be written as

$$P = \begin{bmatrix} p_{00} & p_{01} & p_{0(N-1)} \\ p_{10} & p_{11} & p_{1(N-1)} \\ \cdot\cdot & \cdot\cdot & \cdot\cdot \\ p_{(N-1)0} & p_{(N-1)1} & p_{(N-1)(N-1)} \end{bmatrix}$$

Accordingly, precoding X gives rise to Y as follows:

$$Y = PX$$

$$Ym = \sum_{l=0}^{N\cdot 1} p_{m,i} \quad Xn \qquad\qquad m = 0,1, N-1$$

$p_{m,l}$means lth row and mth column of precoder matrix. The complex baseband OFDM signal with N subcarriers can be written as

$$x_n = \frac{1}{\sqrt{N}} \sum_{m=0}^{N-1} Ym.\, e^{j2\pi\left(\frac{n}{N}\right)m} \qquad n = 0,1, \ldots\ldots N-1$$

The PAPR of OFDM signal in (12) can be written as

$$PAPR = \frac{max|x(n)|^2}{E[|x(n)|^2]}$$

The block diagram of the proposed DCT Precoder based SLM-OFDM system can be shown in fig. 5. Suppose data stream after Serial to parallel conversion is $X = [X_0, X_1, \ldots\ldots, X_{N-1}]^T$ and each data block is multiplied by V dissimilar phase sequences, each length equal to N, $B^{(v)} = [b_{v,0}, b_{v,1}, \ldots\ldots, b_{v,N-1}]^T$,(v= 1, 2…V), which results in the altered data blocks. Let us denote the altered data block for the vth phase sequence is given by

$$X^{(v)} = [X_0 b_{v,0}, X_1 b_{v,1}, \ldots\ldots, X_{N-1} b_{v,N-1}]^T \quad v = (1,2 \ldots\ldots V)$$

Each X_n^v can be defined as

$$X_n^v = X_n b_{v,n} \qquad (1 \le v \le V)$$

Now we pass the signal given in equation (11) through our DCT Precoder based precoder and the resultant signal can be written as

$$Y_m^v = \sum_{l=0}^{N\cdot 1} p_{m,n} \quad X_n^v \qquad\qquad m = 0,1,N-1$$

where $p_{m,n}$ means precoding matrix of nth row & mth column the signal in equation (11) after performing the IFFT can be written as

$$x_n^v = \frac{1}{\sqrt{N}} \sum_{m=0}^{N-1} Y_m^v . e^{j2\pi\left(\frac{n}{N}\right)m} \qquad n = 0,1,\ldots\ldots N-1$$

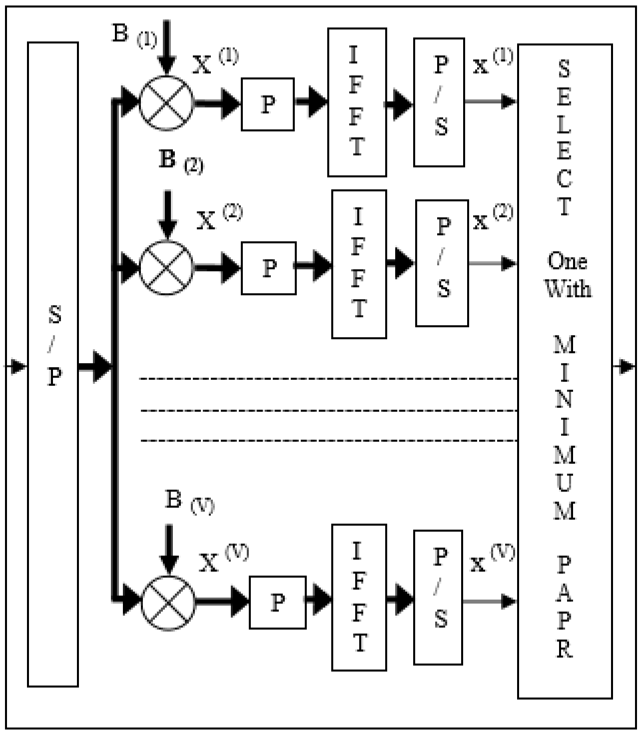


Fig. 5.2 Block Diagram of DCT Precoder based SLM-OFDM System

where v = (1, 2… V) and the PAPR of OFDM signal in (18) can be written as

$$PAPR = \frac{max|x_n^v|^2}{E[|x_n^v|^2]}$$

5.2 PAPR PERFORMANCE PARAMETER

The system is modeled using MATLAB to study the effect of SLM-DCT based PAPR reduction techniques. The aim of doing the simulations is to evaluate the performance PAPR reduction techniques. Different parameters used in the system simulation are given. Simulation is done under the assumption that proper synchronization is maintained between the transmitter and the receiver. The length of the cyclic prefix is chosen to be greater than the maximum delay spread in order to avoid inter symbol interference. Simulations are carried out for different signal- to-noise ratios (SNR).

According to the idea in SLM the original data block will be converted into several independent signals and the signal having lowest PAPR is going to be transmitted. To get back the original data block it must be required to send side information as a set of bits along with the selected signal. The erroneous detection of this side information will give arise to loss of the whole data block. So this is one of the disadvantages of SLM technique. Another disadvantage of this technique is its high complexity due to presence of a lot of IFFT blocks before selecting a particular OFDM signal. Here a method being being proposed to generate a random matrix from the existing phase matrix of the classical SLM technique which fullfils the criteria that the new matrix has less number of rows than that of the existing matrix.

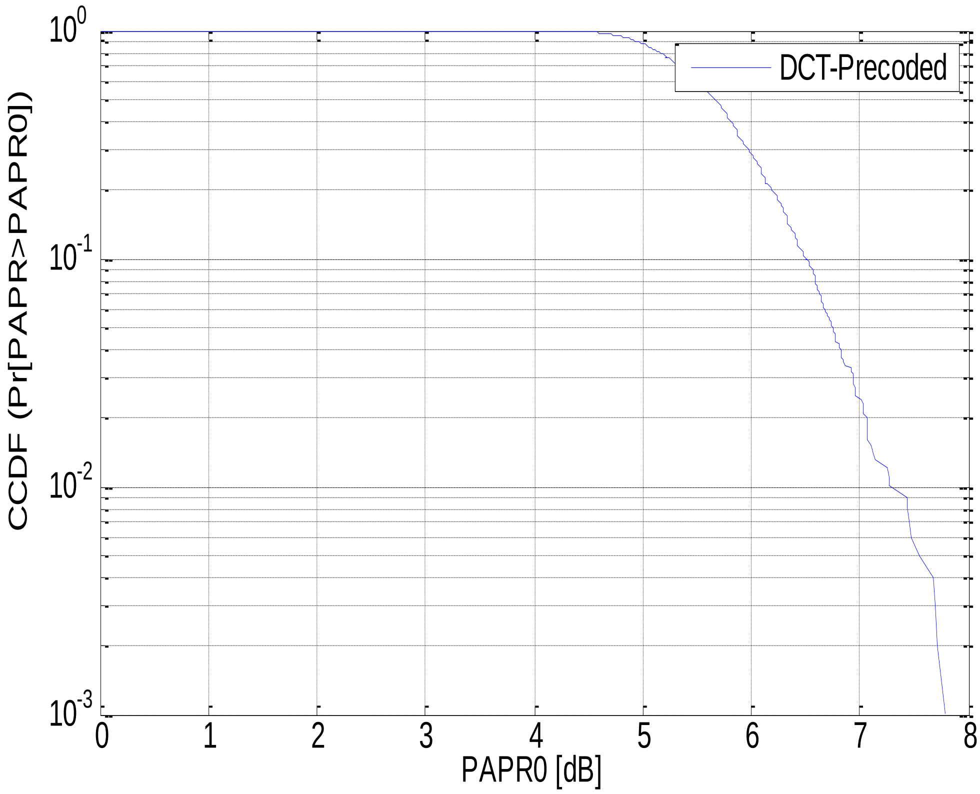


Figure 5.3 CCDF of OFDM System, DCT-Precoder based PAPR Reduction Technique.

At present a sub career processing (SCP) technique have been used to reduce PAPR by more than 5 dB. In OFCDM a Partial Transmit Sequence (PR-PTS) technique has been used for the reduction of PMEPR and its performance has been evaluated with pseudo-random Selective Mapping (PRSLM). So, based on their analyses it is found that PR-PTS has the ability to reduce PMEPR for OFCDM by up to 60% (11 dB), which is quite a significant decrease. This helps to improve the strict requirements on the DAC and the HPA. Thus, we will use other technique to further reduce PAPR ratio in OFCDM

We presented an efficient method to reduce the PAPR of the OFDM signal. The new model combines the features of DCT SLM as well as that of modified SLM to further reduce PAPR of the signal than they perform individually. The proposed method has been realized in two ways- scheme 1 and 2. In scheme1 DCT is used before the IFFT block in Modified SLM and in scheme 2 DCT is used after the Modified SLM block. Simulation results shows that Scheme 1 is having better reduction performance than the scheme 2. The result shows that in DCT SLM with 8 blocks representing the same information, the PAPR got reduced to 6 db, reducing almost 5.8 db from the normal

OFDM system which can be improved further by increasing the number of blocks that represents the same information, which increases the complexity of the architecture.

In this thesis author have shown that OFCDM has different PMEPR characteristics than OFDM and in fact the PMEPR for OFCDM is much greater than that for OFDM. Appreciating the need of reducing the PMEPR for OFCDM, they examine the PMEPR reduction capabilities of SLM and PTS and propose a solution to the problem. They also shown that only a special type of SLM and PTS provide consistent PMEPR reduction for OFCDM. Two techniques to reduce the PMEPR i.e. SLM and PTS were tested with a number of configurations and their performance was compared. Based on their analyses and observations, it was found that adjacent and interleaved segmentation methods for PTS do not provide a guaranteed reduction in PMEPR even when the number of segments is increased. Meanwhile, the use of PRPTS led to a significant reduction in PMEPR. In fact, the performance of PR-PTS with OFCDM is identical to that of PR-PTS with OFDM. The use of SLM, where phase sequences were generated in a random manner, also led to significant reduction of PMEPR; however, PR-PTS performed slightly better than SLM.

CHAPTER-06

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

Physical layer configuration is a critical part of any correspondence framework and profoundly affects the attainability of correspondence forms at higher layers. OFDM based transmission is a promising contender to accomplish high information rates by means of aggregate use of an expansive number of subcarriers. In spite of its few favorable circumstances, it experiences two noteworthy disservices, which are high PAPR and ICI. In this manner, PAPR lessening and ICI wiping out are two noteworthy difficulties in executing an OFDM framework. This theory introduces the investigation of existing PAPR diminishment and some mainstream ICI wiping out plans and proposes answers for enhanced PAPR lessening. It additionally proposes a PAPR diminishment plot for OFDM framework using an ICI wiping out plan.

OFDM procedures permit the transmission of high information rates over broadband radio channels subject to multipath blurring without the requirement for ground-breaking channel leveling. Anyway it is exceptionally delicate to nonlinear impacts because of the high PAPR possessed by their transmitted signs. Slimane Ben Slimane (2007) proposed a proficient system for decreasing the PAPR of OFDM signals. The proposed system is information autonomous that does not require new preparing and enhancement for each transmitted OFDM square. The diminishment in PAPR of the OFDM flag is gotten through a legitimate choice of a precoding plan that disseminates the intensity of each balanced image over the OFDM square. The got comes about demonstrate that this precoding plan is an appealing answer for the PAPR issue of OFDM signals. It is appeared, through PC reenactments, that the PAPR of precoded OFDM signals approaches that of single-transporter signals. The great change in PAPR given by the present strategy allows the decrease of the unpredictability and cost of the transmitter altogether. The precoding plans likewise exploit the recurrence varieties of the correspondence channel and can give impressive execution pick up in blurring multipath channels.

It has been discovered that the PAPR decrease ability of SLM-OFDM framework utilizing altered turbulent arrangement is no less than 0.4dB superior to anything that of adjusted Hadamard succession. It has been additionally discovered that the PAPR execution of SLM-OFDM framework with adjusted disorderly succession is likewise superior to that of the proportional PTS-OFDM framework. The PAPR diminishment capacities of PTS-OFDM framework utilizing quaternary to 8-QAM mapping and MPSM, for a similar number of elective successions, are close. The proposed quaternary to 8-QAM and quaternary to 8-PSK mapping plans beat as far as BER execution over existing MPSM on the grounds that proposed M-2M mapping for SLM and PTS-OFDM frameworks utilizes just two stage factors and expands the star grouping size by a factor of 2, while existing MPSM plot utilizes four stage factors (1, j, - 1, - j) and broadens the heavenly body measure by a.

Research is being done to limit the impacts of high PAPR in OFDM frameworks, cutting is a straightforward arrangement that outcomes from this examination. Section is a non-direct task that presents intermodulation commotion and out-of-band radiation in the OFDM flag. With a specific end goal to moderate the commotion presented by cut-out a few techniques have been proposed, such as filtering in the wake of section to lessen the out-of-band radiation and the DAR and IDAR strategies to decrease the intermodulation clamor. A variety of the IDAR technique, called IDARF, has been proposed in this task with a specific end goal to enhance its execution.

When utilizing the 16QAM adjustment, DAR and IDAR have comparative execution when no filter is connected at the transmitter, this execution is additionally fundamentally the same as that of IDARF when the FFT filter is connected at the transmitter, in spite of the fact that IDARF performs somewhat better. At the point when the balance utilized is 64QAM, IDAR performs superior to DAR without filter at the transmitter and they both have comparable conduct. IDARF, then again, performs obviously superior to anything DAR and IDAR and its conduct is nearer to the situation when no cut-out is connected than to IDAR and DAR.

.

In this proposition, we proposed a DCT precoder based SLM strategy to lessen the high PAPR created by multi bearer regulation in the OFDM framework. At cut rate of 〖10〗^(- 3),N=64 and V=16 this system can decrease PAPR up to around 5.5dB. Our proposed strategy can diminish more PAPR on the off chance that we increment the estimation of V, yet with the expansion in the estimation of V the computational intricacy is additionally expanded. In this way, the estimation of V ought to be picked deliberately. Furthermore, this method is proficient, flag autonomous, distortionless, it doesn't require any unpredictable advancement

6.2 FUTURE SCOPE

The search for a good PAPR reduction and ICI cancellation scheme for OFDM systems still faces many challenges. Future research could be carried out in the following directions to further improve the PAPR reduction and ICI cancellation in OFDM systems.

- ✓ Criterion for parameters selection to optimize both BER and PAPR performances of QCT.
- ✓ In this thesis we have derived the Precoding functions for DCT, which are functions of three independent parameters . By taking few sets of these parameters as examples, we have shown a trade-off between PAPR reduction capability and BER performance, and proved the outperformance of the proposed schemes over EC, TC and TDBC. However, there is still a need to find a criterion for independent selection of parameters for joint optimization of PAPR and BER performances.

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