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A SURVEY OF PAPR REDUCTION IN OFDM SIGNALS

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Abstract

In Radio waves, the digital data can be transmitted using Burst number of data using OFDM technique. So only an OFDM Technique is called attractive modulation techniques. In this OFDM signal transmission having so many disadvantages, one of the main disadvantages is a Peak average power which is due to combination of sinusoidal leads to high peak-to power ratio (PAPR).Due to High PAPR, which leads to poor (i.e) degrades the signal performance of power amplifier in transmission, this PAPR can be reduce using some of the following technique like, there are Clipping, Coding, Partial transmit sequence (PTS), Sequential Mapping(SM), Tone reservation (TR), Tone injection (TI), Interleaving, Nonlinear companding transform, & Hadamard transform etc.Various technique are available to reduce the Peak power and discuss detail about the merits and demerits .

Key words: Orthogonal Frequency Division Multiplexing, Peak to Average Power Ratio (PAPR), Partial Transmit Sequence (PTS), Sequential Mapping (SM), Tone Reservation (TR), Tone Injection (TI).

INTRODUCTION

Introduction in previous technique of we used Frequency division Multiplexing technique (FDM), in this techniques no separate carriers can be used.. In Orthogonal Frequency Division Multiplexing (OFDM), the whole channel it can be sub divided into more number of symbol there by contracted parallel sub channels, which growing the representation of signal duration and reducing or eliminate the Inter Symbol interference which is due to the the multipath. Merits of OFDM is less bandwidth occupation without any Inter Carrier Interference large data rate ,increased security and simple guard interval makes this OFDMA effective in multipath signal Transmission .permit to entire high data rate as compared to FDM, enlarged protection and bandwidth effectiveness possible using CDMA – OFDM (MC-CDMA) & easy safeguard interval make the scheme new strong to multipath things.

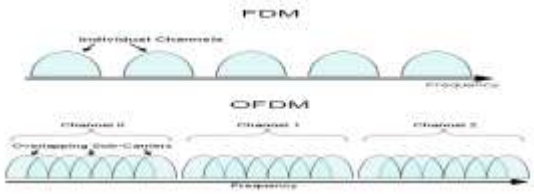


Fig.1.1 FDM vs OFDM

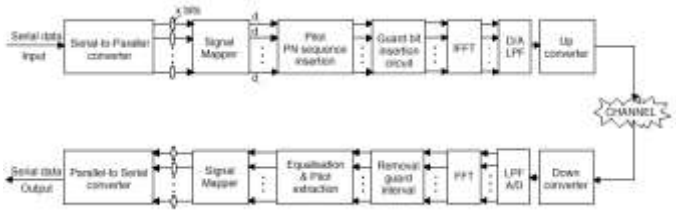


Fig 1.2. Block diagram of OFDM Systems

Several techniques permitting a better use the spectral band of the channel exist.[8] Traditionally, more bandwidth is required for higher data-rate transmission in wireless local area networks, wireless metropolitan area networks, digital audio broadcasting, and digital video broadcasting. OFDM having following disadvantages, the OFDM signal has more noise in amplitude of of the signal and requires large dynamic range. To avoid this amplitude like noise we require RF power amplifiers with a high peak to average power ratio, but this Power amplifier is more sensitive to carrier frequency offset and drift which results in leakage of DFT signals. So we need to reduce the PAPR for efficient transmission of multicarrier signals. The OFDM signal has a noise like amplitude with a very large dynamic range, therefore it requires RF power amplifiers with a high peak to average power ratio and It is more sensitive to carrier frequency offset and drift than single carrier systems are due to leakage of the DFT. The PAPR Reduce the PAPR Reduction for efficient transmission.

Peak to average Power ratio is a ratio of Peak Power to average Power termed as Peak-to-Average Power Ratio [1]. Mathematical representation is given below.

$$PAPR = Ppeak / Paverage = \max [|xn|2] / E [|xn|2]$$

Where, Ppeak = Peak power of the OFDM system

Paverage = average power of the OFDM system.

The Effect of High PAPR is 1. The effect of High PAPR results in signal peak crosses over the threshold value. The Frequency of peak occurrence is less. 2. Peak to average Power ratio is a ratio between the Peak Power to average Power termed as Peak-to-Average Power Ratio [1]. Mathematical representation has been given below. The Effect of High PAPR: 1. the effect of High PAPR implies that the peak value of the signal is greater than the Threshold value. The Frequency of peak occurrence is low. 2. In typical OFDM systems, Due to the more number of sub-carriers the received signal amplitude is large which leads to in-band distortion and out Due to the large number of sub-carriers in typical OFDM systems, the amplitude of the Received signal has a large value, leading to in-band distortion and out-of-band radiation. [3]. In AM Systems: complexity of Digital to analog converter Power Amplifier with larger dynamic range Increased Power consumption, component cost.5. Reduction is efficiency of RF amplifiers [5]. This paper discusses all the outstanding PAPR reduction techniques described above.

II. PAPR REDUCTION TECHNIQUES

Many techniques are available to reduce the PAPR technique has been proposed in the symbols. These techniques are divided into two different groups. These are signal scramble techniques and signal alteration technique. [4]

2.1. SIGNAL SCRAMBLING TECHNIQUES

Block Coding scheme ,Selected mapping (SLM) ,Partial Transmit Sequence (PTS) Interleaving Technique, Tone Reservation (TR), Tone Injection (TI) etc are Signal Scrambling Techniques.

2.1.1 CLIPPING/FILTERING

this technique is very simple method of PAPR reduction. A Maximum amplitude level is set to limit the peak envelope of the input signal. When a signal has high value exceeding fixed threshold level are clipped and the rest is allowed through Amplitude clipping is a easy way to reduce the Peak power reduction in OFDM systems. A Maximum threshold assessment set to the amplitude of peak signal ,in this case to limit the peak envelope of the input signal .Signal having value greater than this Threshold value are clipped and reset are allowed to pass through un-disturbed .A threshold level of the amplitude is fixed in this process and any sub-carrier having amplitude more than this level is clipped or filtered, which in turn reduces PAPR value[2].

$$B(x)= \begin{cases} x & |x|\leq A \\ Ae^{j\Phi(x)} & |x|\leq A \end{cases}$$

B(x) = the amplitude value after clipping.

x = the initial signal value.

A = the threshold set by the user for clipping the signal.

2.1.2. INTERLEAVING

This method is also termed as Adaptive Symbol Selection Method .Multiple OFDM symbols are created by bit interleaving of input sequences .The basic Idea is to use W interleaving ways and selecting one with the lowest PAPR. PAPR Reduction capability depends on the number of interleaver used to recover the signals the receiver needs to know the information about which interleaver is used [4].

2.1.3. COMPANDING

The idea of companding came from the Compressor and expander of speech signal and that the OFDM signal is similar to it from the fact that large signals occur very infrequently. Companding are of two types- symmetry and unsymmetry. Linear companding focus on increasing small signals only while non-linear companding .Companding scheme produced degradation in BER performance. So compndaing improves the PAPR in expense of the BER functioning of the systems can be increased

2.1.4. CODING

Massive PAPR reduction can be achieve if the lengthy information sequence is separated. All sub block encoded with System on a Programmable Chip (SOPC). When FEC codes are used to mitigate the understand of the distortion

techniques, the OFDM is term as COFDM so that the signal degradation can be made less. The basic concept is that when N signals are added in phase they add up to the signal power, such arrangements can be made with different coding schemes like Simple Odd Parity Code (SOBC), returning Coding (RC), Simple Block Code (SBC) Complement Block Coding (CBC) and Modified Complement Block Coding (MCBC), Reed-Solomon, Simplex codes [02], Reed-Muller codes and Golay complementary codes described in [09][08] can significantly reduce PAPR.

2.1.4.1 Block coding techniques

Block coding techniques This method is to reduce PAPR using different block coding & set of code words. This scheme is commonly used to reduce the peak to mean envelope power ratio. While selection of the proper codeword many things must be careful like M-ray phase modulation system, any type of coding rate, suitable for encoding –decoding & also main thing is that error correction /error decoding.

2.1.4.2 Sub Block Coding Techniques

PAPR is reduced by using more than 3db sub block coding technique. But this can be done achieve at ¾ code rate. This techniques based on ¾ code rate methodically with added final odd parity checking bit to develop less peak covering power. This coding method is termed as systematic odd parity checking coding (SOPC). Large reduction in PAPR can be obtained by the divided large frame into sub block encoded with SOPC.

2.2. SELECTED MAPPING

The Selective Mapping Technique was initially penned down by Bamul,Fischer and Huber in 1996. It is one of the positive lessening techniques as there is no distortion. It is a category of phase rotation approaches. Phase-rotated data with depressed PAPR will be preferred to transmit (0). By means of SLM technique, key in data is fragmented into subordinate data blocks of length below F sequence, and this should be transformed into parallel by using serial to parallel converter. The product of this parallel data blocks and the phase sequences will fabricate new input information sequences. The phase sequence is given as

$$Kx = (K1,K2,K3\ldots\ldots KX) \qquad \text{---------- (1)}$$

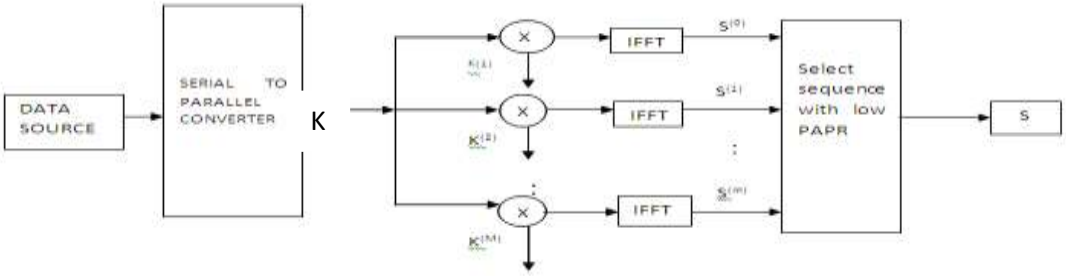
Where x= [0, 1, 2....X], to make OFDM data blocks to be phase rotated. Therefore S(x) expressed as,

$$S(x) = (s0(x),s1(x),s2(x).....sM-1(x))T$$

$$= [K0(x)s0,K1(x)S1,.....KM-1(x)SM-1]T$$

$$=K(x)S \qquad \text{---------- (2)}$$

After the phase rotation of data blocks, they put on identical information as the original OFDM data blocks. Now signal in frequency domain changed into time domain s(X), by undergoing the operation of IFFT. The fundamental idea that lies in this technique the signal with less PAPR will be preferred. To pick up the data at the receiver side, the side information index (SII) should be transmitted. The amount of reduction build upon the number of phase sequences S and its design



2.3. PARTIAL TRANSMIT SEQUENCES

In the PTS technique, an input data block of total symbols is partitioned into sub blocks. The subcarriers in each sub block are weighted by a phase factor for that each sub block. The phase factors are selected such that the PAPR of the combined signal is minimized. The ordinary PTS technique has exponentially increasing search complexity. To reduce the search complexity. These methods achieve significant reduction in search complexity with marginal PAPR performance degradation.

2.4. TONE RESERVATION AND TONE INJECTION

In this system a several set of tone are set aside called as peak reduction carriers and these are added to the data signal to isolate energy to cancel large peaks. These tones does not bear any information and are orthogonal to each other while Tone Injection technique reduces the PAPR without reducing the data rate similar to ACE some group points are extensive external the signal collection but in a different way than in ACE[10] . Extra flexibility is provided by mapping points of original constellation into extended constellation and then by combining the data signal and Peak reduction carrier so generated By maximizing signal-to-distortion ratio error probability can be increased for the same transmit power and same order of computational cost in the tone Reservation method

CRITERIA FOR SELECTION OF PAPR REDUCTION

A quantity of factor should be measured while choosing the particular method to reduce the Peak Power system. These factor consist of PAPR reduction capacity, signal distortion, speed hit, side information, complexity, enlarge power in the transmit signal, BER enlarge at the receiver, computation complexity raise and so on. The criteria are mutually dependent. Each criterion is a relative value. PAPR reduction capabilities of various methods and each criterion are related and shown in the table I.

All these criteria vary with the type of technique selected for PAPR reduction.

- PAPR reduction capability
- □ Rate hit
- □ Side Information, SI
- □ Bit Error Rate Degradation
- □Signal alteration
- □ Complexity

METHOD	CLIPPING	SLM	PTS	CODING
PAPR Reduction	***	**	**	***
Date Rate	*	****	****	***
Side Information	*	***	***	*
Complexity	*	****	****	***
Power rate	*	*	*	*
BER Performance	**	***	***	*
Noise	***	*	*	*

**** = Low - High
***High
**Medium
*Low

3.1 PAPR REDUCTION CAPABILITY

Clearly, this is the most important issue in choose a PAPR reduction method.For example, the amplitude clipping process clearly remove the time area signal peak, but results in in-band signal alteration and out-of-band signal alteration.

3.2 POWER INCREASE IN TRANSMIT SIGNAL

Some methods are need to improve a power in the transmit signal after using PAPR reduction techniques. For example, TR require new signal power because ,some power should be used for the PRCs. TI use a set of equivalent collection points for an novel constellation point to reduce PAPR. Since all the equivalent constellation points require more power than the new constellation point, the transmit signal will have more power after applying TI. When the transmit signal power should be equal or less than that before using a PAPR reduction technique, the transmit signal should be normalize the recovered the back to the original power signal, resulting in BER performance degradation for these method.

3.3 BER INCREASE AT THE RECEIVER

This is one of the most important issue and very much associated to the increase the power in the transmit side. Some systems are to increase the BER at the receiver side if the transmit power signal is permanent or For example, the BER after applying ACE will be decreased, if the transmit signal power is fixed. In some techniques such as SLM, PTS, and interleaving, the whole data block may be lost if the side information is received in error. This may also increase the BER at the receiver.

3.4 LOSS IN DATA RATE

Some techniques require the data rate to be reduced. As shown in the previous example, the block coding technique is need the ¼ information symbols to be committed to calculating PAPR. In SLM, PTS, and interleaving, the data rate is reduced because of side information used to update the receiver of what has been done in the transmitter. In this method the side information may be expected the an error unless some form of protection such as channel coding is employed. When channel coding is used we can avoid the data loss in the data rate due to side information is increased future.

COMPARISION OF THE PAPR-REDUCED SIGNALS

Reduction Technique	Parameters			Operational Required at transmitter (TX)/Receiver(RX)
	Decrease Distortion	Power raise	Defeat data rate	
Clipping and Filtering	NO	NO	NO	TX:Clipping RX:None
Selective Mapping(SLM)	Yes	NO	Yes	TX:M Times IDFT Operations RX:Side information Extraction,Inverse SLM
Block Coding	Yes	NO	Yes	TX:Coding or Table Searching RX: Decoding or Table Searching
Partial Transmit Sequence (PTS)	Yes	NO	Yes	TX:N Times IDFT Operations RX:Side Information extraction,Inverse PTS
Interleaving	Yes	NO	Yes	TX:D Times IDFT Operation,D-1 times Interleaving RX: Side information Extraction , De-Interleaving
Tone Reservation (TR)	Yes	Yes	Yes	
Tone Injection (TI)	Yes	Yes	NO	

Table 1.Comparsion of Variation Technique

IV. CONCLUSION

In the above described techniques to reduce the PAPR in OFDM system all techniques is different in their way,and using each technique PAPR will be reduced at some what level. To reduce the PAPR any technique can be used.

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