International Recognized Double-Blind Peer Reviewed Multidisciplinary Research Journal
Golden Research Thoughts
ISSN 2231-5063 Impact Factor : 3.4052 (UIF)
Volume - 4 | Issue - 11 | May - 2015 Available online at www.lbp.world

OFDM PAPR REDUCTION TECHNIQUES

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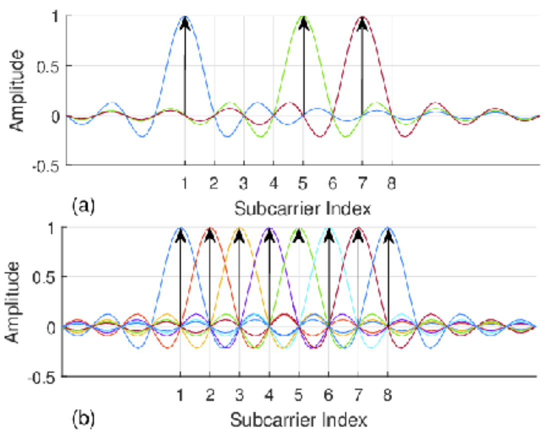

ABSTRACT

Orthogonal division multiplexing (OFDM) is a modern transmission technology widely used in many digital communications. It uses modulated multiple carriers at once. Although they overlap, due to the sub-carrier's orthogonally, they can be simulated using the appropriate time window on the receiver. OFDM is effective against frequency selective extinction providing inter-symbol interference and high spectral efficiency. The main drawback of this system that reduces its efficiency is the distortion of the signal originating at the transmitter's high power mmp amplifier (HPA), known as the Peak-to-Average-Ratio (PAPR). In this paper we will analyze the various techniques used to reduce PAPR in OFDM systems. Simulation is used to analyze the efficiency of the technique used, which shows a weight OFDM that provides better PAPR reduction and a better bit error rate (BER).

KEY WORDS: PAPR, OFDM, PTS (Partial Transmit Scheme), BER.

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INTRODUCTION:

With the demand for high quality communication services in 4G and 5G, improving the quality of service (QoS) was a major challenge and reduced latency time. To overcome and meet this requirement, we encountered a technique called orthogonal frequency division multiplexing (OFDM). This impacts many things, such as maintaining high data rates, high bandwidth performance, low computational complexity, and eliminating multipath fading. OFDM is a special case of Frequency Division Multiplexing (FDM), which the US National Defense Department uses for military communications. Compared with traditional FDM, OFDM allows the spectrum of different subcarriers that are orthogonal to overlap with each other, which improves the spectral efficiency of the system. The concept of OFDM technology was first proposed in 1965 by RW Chang. In 1967, Saltzberg analyzed the performance of the OFDM system. In 1970.1, OFDM technology was patented at UFPD and later used in military communication systems. In 1971, SB Wynstern and PM Ebert worked on the Discrete Fourier Transform (DFT) at MCM. In fact, the implementation of DFT's Fast Fourier Transform (FFT) has made OFDM modulation and demodulation viable and successful. In the 1980s, ISI was reduced when Peled and Ruiz added a cyclic prefix (CP) to the basic OFDM signal to maintain orthogonality in the sub-carriers.

Orthogonal division multiplexing (OFDM) is a digital technology, widely used in many digital communication systems such as WLANs and 4G Mobile Communication. Due to its flexibility for multi-path feeding and high spectral efficiency, it provides high and good bit rates. It also facilitates a larger number of carriers subjected to orthogonality compared to the traditional frequency division multiplexing. It uses modulated multiple carriers at once. Although they overlap, due to the subcarrier's orthogonality they can be demoted using the appropriate time window on the receiver. OFDM is effective against inter-symbol interference and frequency selective extinction Provides high spectral efficiency Quadratic amplitude modulation (QAM) and phase shift keys are used to modulate each copy carrier at the symbol rate. Data rates are maintained according to traditional single carrier modulation schemes with the same bandwidth. The main drawback of this system that reduces its efficiency is the distortion of the signal at the transmitter's high power mp amplifier (HPA), known as the peak-to-average-ratio (PAPR). PAPR causes loss of efficiency. HPA non-linearity leads to higher BER in band distortion and inter channel interference.

SYSTEM OF OFDMR AND PAPR:

System of OFDM:

Orthogonal Frequency Division Multiplexing (OFDM) is the most efficient and widely used multiplexing and modulation technology for 4G and 5G telecommunication standards including digital radio broadcasting, digital terrestrial television (DTT), wireless local area network (LAN) network, Two-part transmitter side and receiver side.

The idea of OFDM comes from the Multi Carrier Modulation (MCM) transmission technology. The principle of MCM describes the division of input bit streams into several parallel bit streams, and they are then used to modulate several sub-carriers as shown in Figure 1. Each sub-carrier is separated by a guard band so that they do not overlap. General Chat Chat Lounge on the receiver side, band pass filters are used to separate the spectrum of independent subcarriers. OFDM is a special form of significantly efficient MCM technology, in which dense gaps use orthogonal subcarriers and overlapping spectrum. Because of the orthogonally of the subcarriers, the use of band pass filters in OFDM is not required.

Therefore, the available bandwidth is used very efficiently without intercarrier interference (ICI). In Figure 1, the result is a significant reduction of the bandwidth required by removing the guard band and allowing the subcarrier to overlap. If orthogonality is maintained, it is possible to recover an independent subcarrier despite their overlapping spectrum. Orthogonally is achieved by fast Fourier transform (FFT) at the input stream. Because of the combination of multiple low data rate sub-carriers, OFDM offers high data rates combined with long symbol periods. This reduces or completely eliminates the risk of inter-symbolic interference (ISI) by channel consistency time, which is a common occurrence in multipath channel environments with short symbol duration. The use of cyclic prefix (CP) in OFDM symbols can further reduce the effect of ISI, but also a loss in SNR and data rate.

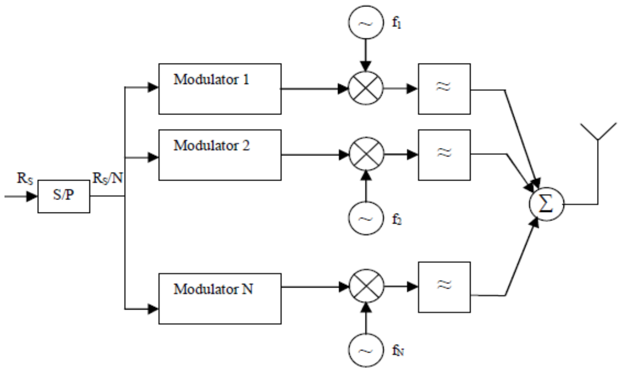

Figure 1 Block Diagram of Generic MGM Transmitter

Transceiver of OFDM:

The basic principle of OFDM is to split the available bandwidth into multiple sub-carriers. As the number of carrier's increases, it becomes more immune to frequency selective extinction, and data rates are also rising. However, the number of sub-carriers cannot be increased arbitrarily because it increases the complex architecture of the system and the sign duration that makes the transmission more sensitive to the time discrepancy of the channel. The problem of the system's complex design was handled by Weinstein and Ebert with the implementation of OFDM modulation by Inverse Discrete Fourier Transform (IDFT) and demodulation by Discrete Fourier Transform (DFT). To illustrate this, N is considered to be an OFDM symbol with a different subcarrier, and suppose s (t) is mentioned each time interval Ts = n.

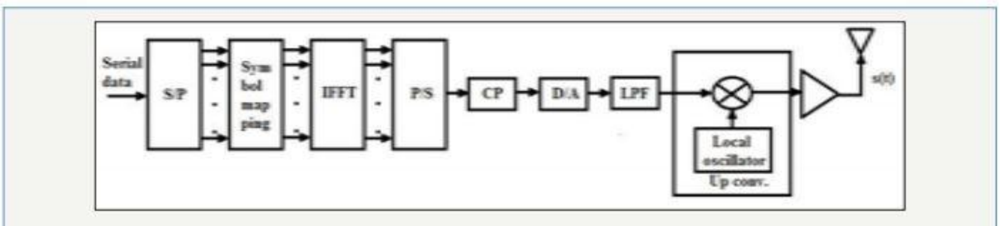

Figure 1: OFDM system transmitter.

Figure 1: Block Diagram of OFDM System Transmitter

Implementation of OFDM System:

The principles of OFDM as an efficient MCM technique were already in the 50's and 60's. However, technical difficulties such as digital implementation of FFT / IFFT delayed system implementation, which at that time could not be resolved. In 1950's and 1960's, Cooley and Tucci introduced algorithms for FFT calculations, and then their effective implementation on the chip was applied to OFDM. The digital implementation of the OFDM system is done through the mathematical operation of the Discrete Fourier Transform (DFT) and its equivalent derivative Discrete Fourier transform (IDFT). These two operations are widely used to exchange data between the time domain and the frequency domain. In the case of OFDM, these transformations can be viewed as data mapping on an orthogonal subcarrier. In order to perform frequency domain data in time domain data, IDFT correlates frequency domain input data with its orthogonal base functions, which are sinusoid at specific frequencies. In other ways, this correlation is equivalent to mapping input data to sinusoidal base functions. In practice, OFDM systems combine fast Fourier transform (FFT) and inverse fast Fourier transform (IFFT) blocks, which are mathematically equivalent versions of DFT and IDFT. Beside the transmitter, an OFDM system treats source signals as if they were in the frequency domain. These signals feed the IFFT block, which brings the signal into the time domain. If a sub number of subsets of carriers is selected for the system, the basic function for IFFT is to obtain n orthogonal sinusoids of different frequency and IFFT to receive n signs at a time. Each N complex valuable input symbols determine both the amplitude and the phase of the sinusoid for that subcarrier. The output of IFFT is the essence of all n sinusoids and makes a single OFDM seismol. The length of the OFDM symbol is NT where T is the IFFT input mark duration. Thus, the IFFT block N provides an easy way to modulate data on an orthogonal subcarrier.

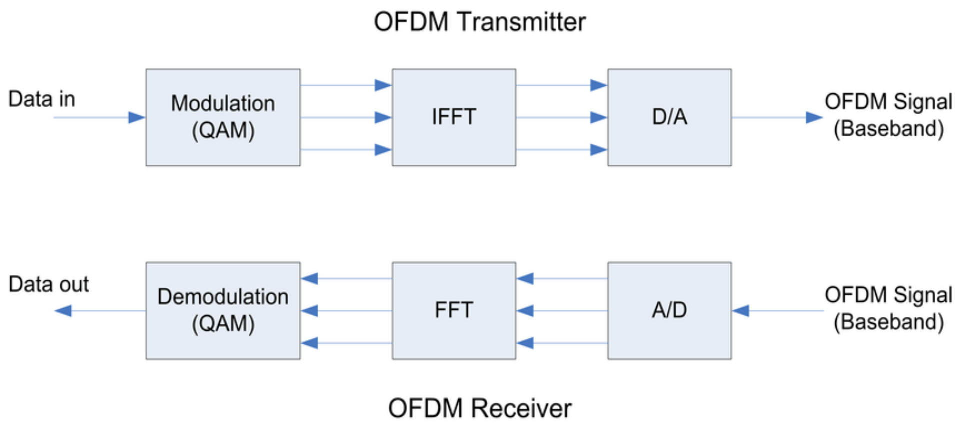

Figure 2 - Block Diagram of Transmitter and Receiver

PAPR in OFDM System:

The high peak-to-average power ratio was identified as a major practical issue with OFDM modulation. The nature of the modulation results in higher PAPR where multiple subcarriers / sinusoids are combined to form a signal to be transmitted. When N adds sinusoids, the value of the crop's magnitude is N, where the average may be lower due to destructive interference with sinusoids. Higher PAPR signals are often undesirable because they usually strain in the analog circuitry. High PAPR signals require a large amount of dynamic linearity from analog circuits, which typically consume high power with expensive equipment and low efficiency. The PAPR of the transmitted signal x (t) is the ratio of maximum instantaneous power and average power.

$$PAPR = \frac{Max\,[x(t)^2]}{0 \le t \le T\; E\{|x(t)|^2\}} \qquad 1$$

The linear effects on infected OFDM symbols are spectral diffusion, inter-modulation, and signal constellation change. In other words, nonlinear distortion interferes with both in-band and out-bands signals. Inbound interference increases the bit error rate (BER) of the received signal, while out-of-phase interference leads to near-channel interference by spectral diffusion. A good solution is to prevent the occurrence of such nonlinear distortions by reducing the PAPR of the transmitted signal with the self-handling of OFDM signals.

1. Partial Transmission Techniques: Large peak-to-average power (PAP) ratio that incorporates nonlinear components such as a power amplifier (PA) into the transmitter while distorting the signal. This is because the power amplifier on the transmitter enters the saturation region rather than in the linear region, causing distortion. A transmitted signal that results in increased BER to the next receiver. In other words, nonlinear distortion interferes with both in-band and out-bands signals. Therefore, PA requires approximately PAPR equalization for distortion-less transmission. This reduces the efficiency of the amplifier. Therefore, reducing PAPR is of practical interest. Several PAPR reduction methods have been proposed. The relative weakness is increased strength and complexity of implementation. OFDM is adopted in various communication applications such as Digital Video Broadcasting (DVB), Digital Audio Broadcasting (DAB) and Wireless Local Area Network (WLAN). As a result, high PAPR of the transmitted signal causes nonlinear distortion at high power amplifier (HPA) and its energy efficiency is reduced. Also, the distortion of the signal is worsening proximity channel interference and high bit error rate (BER). To avoid the appearance of large PAPRs of OFDM signals, different methods for PAPR reduction have been proposed. Of all the existing methods, partial transmit sequences (PTS) are an attractive solution due to the good performance of PAPR reduction In the PTS method, the input data symbols are separated into separate sub-blocks and the sub-blocks are phase-rotated individually through the step-by-step process of improving the efficiency of PAPR.

In 1997, Muller and Huber proposed an effective and flexible crop power reduction scheme for OFDM systems by combining partial transmit sequences (PTSs). The main idea behind this scheme is that the data block is subdivided into non-overlapping plots, and each sub block is statically rotated by a separate rotation factor. The rotation factor, which generates time domain data with the lowest peak amplitude, is also transmitted to the receiver as side information. PTS is a possible strategy to reduce PAPR. The PTS scheme can be interpreted as a structurally modified case of the SLM scheme and it has been shown that the PTS schemes perform better than the SLM schemes. When differential modulation is used in each sub block, no side information is required to be transferred to the recipient.

2. Selected Mapping: The paper by Baum et al. 1996 proposes a method to reduce the average transmit power of a multicarrier modulation system with the mapping selected in 1996 in. The entire set of candidate signals is equally represented in the selected mapping (SLM) method. Information and subsequently selected and transmitted the most favorable signal with respect to PAPR. Side information about this selection must be clearly disseminated with the signals of the selected candidate. The SLM scheme is one of the earliest possible approaches to reduce PAPR problems, with the aim of having peaks occurring frequently without minimizing its peak. Any sub-carrier can handle this plan and the drawback associated with this plan is the overhead of the side information that needs to be sent to the receiver.

3. CCDF and PAPR: The complementary cumulative distribution function (CCDF) of PAPR is one of the most frequently used performance measures for PAPR reduction techniques. The CCDF curve shows how much the signal spends at or above the power level. The CCDF curve is basically a plot of the relative energy level versus probability. CCDF can be explained mathematically with a set of data containing the probability density function (PDF). The PDF is computed integrally to obtain the cumulative distribution function (CDF). Then reversing the CDF results in the CCDF. It is concluded that CCDF is complementary to CDF or CCDF = 1 - CDF. CCDF measures the efficiency of any PAPR technique. The CCDF probability of PAPR indicates that the PAPR threshold level is below PAPR0, which can be expressed,

CCDF = Pr (PAPR>PAPRO)

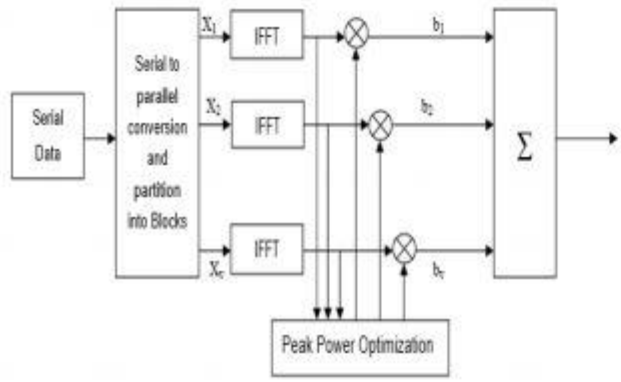

Fig 3 Block Diagram of PTS Technique

4. Tone Injection: This is an additive method that achieves PAPR reduction of multicarrier signals without losing the data rate. The basic idea is to increase the size of the constellation so that each point in the parent constellation can be mapped to several equivalent points in the expanded constellation, as each information unit can be mapped to one of several equivalent constellations, so the freedom to use these extra degrees of PAPR can be deducted. Tone injection is called because changing the basic constellation point for new points in a large constellation is equivalent to injecting the correct phase and frequency tone in a multi-carrier symbol.

5. Clipping: Of all the PAPR reduction techniques, clipping is the simplest and least computationally computational. In clipping, the upper part of the signal outside the allowed threshold is clipped. However, this technique is simple. It has several disadvantages:

- Clipping causes in-band distortion that affects the bit error rate.
- Out-of-band radiation caused by clipping causes side channel interference

To reduce the out-of-band distortion, a filtering operation is started. The clipping and filtering technique for PAPR deduction is used in fig. N denotes the number of subcarriers and L is the oversampling factor. In the movie, the signal generated by the IFFT, ′ [] is the L-times oversampled signal. An FFT-IFFT filter is implemented that allows the signal to pass through a band-pass filter (BPF) and then a low pass filter (LPF). When the signal goes through the LPF, the peak power there increases again. The oversampling factor for the peak power efficiency reduction is set such that the OFDM should be oversampled (L> 3). The corresponding filter reduces out-of-band radiation and thus reduces near-channel interference, thereby reducing BER efficiency.

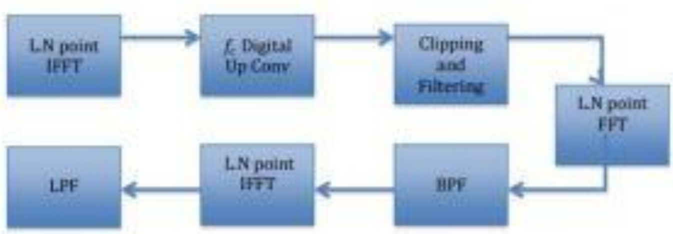

Fig-4 Block Diagram of Clipping and Filtering

6. **Peak to Average Power Ratio:** PAPR occurs when different sub-carriers of the OFDM system converge on the transmitter and result in band deformation in the formation of large peaks. PAPR reduction techniques are used based on system requirements such as data rate loss, spectral efficiency, computational complexity, etc. Multiplexing sub-carriers overlap each other in the orthogonal frequency division. Since they are orthogonal to each other, the product of the two signals is essentially zero.
7. **Companding:** The OFDM signal can be assumed to be Gaussian distributed, and the OFDM signal does not occur occasionally. Whereas a companding technique can be used to improve OPDM transmission performance. The law compounding technique is used to generate the OFFM signal before converting it to an analogue waveform. OFDM signal is compressed and quantized after IFFT is taken. After the D / A conversion, the signal is transmitted through the channel. At the receiver end, the received signal is first converted to digital form and amplified. Compounding is most commonly used in speech processing where high peaks do not occur frequently. OFDM signals also exhibit similar features where high peaks are sometimes not encountered. As the larger signal decreases over a larger volume, the compounding technique improves the magnitude resolution of smaller signals at the cost of deducting the resolution of larger signals. Due to compending, the quantization error is significantly larger for large a signal which degrades the BER performance of the system. Therefore PAPR improves the cost of BER performance of the Compending Technic system.

CONCLUSION:

The major difficulty in the practical implementation of multiplexing orthogonal frequency division is its high PAPR. To transmit signals with a larger PAPR, expensive wide range power enhancers are needed. High PAPR results in a loss of efficiency of the power amplifier. This paper describes the technique of partial transmit sequence (PTS) PAPR reduction. One of the effective ways to reduce PAPR is to use a partial communication sequence scheme. We can use a new phase sequence, we reduce the complexity. The complexity of the scheme can be reduced by the sequencing of the new scheme, but the PAPR deduction is somewhat reduced. So, in the future we can improve the efficiency of PAPR deduction using genetic algorithms.

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