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Peak Cancellation Scheme for reducing PAPR in OFDM

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ABSTRACT: In every wireless communication system in the power amplifier (PA) is use for transmitting and receiving the signal as long as. If we design the PA using different hardware it's required more component and time .PA is the most power-hungry component in a wireless base station transmitter, and reducing the peak-to-average power ratio (PAPR) of wireless signals is an important issue for its effective use. In this paper, we focus on implementation of the peak cancellation (PC) technique for multiple signal, which is known as the simplest method for PAPR reduction. Peak cancellation (PC) is known as one of the simplest peak-to-average power ratio (PAPR) reduction techniques that are applicable to various communications standards. The salient advantage of PC is its ease of hardware implementation, but it induces in-band distortion and out-of-band radiation. In order to restrict the amount of distortion within an acceptable level, it is critical to carefully design the cancelling pulses as well as the envelope threshold over which PC is applied.

KEY WORDS*:* OFDM, Peak cancellation, PAPR reduction, CFR reduction, EVM, ACLR.

I .INTRODUCTION

ORTHOGONAL frequency division multiplexing (OFDM) is a promising solution for high data rate transmission in Frequency-selective fading channels. It is a multicarrier modulation technique that has newly found wide implementation in a wide variety of high data rate communication system, including digital subscriber lines (DSL), wireless LAN's, digital video broadcasting, now WiMAX and many other emerging wireless broadband system. OFDM"s popularity for high data rate application stems mainly from its efficient and flexible supervision of intersymbol interfence (ISI) in highly dispersive channels. The main principle of an OFDM system is to use the serial-to-parallel transform to assign the high data rate stream on some of the relative low data rate parallel and orthogonal sub channels Due to the low transmission data rate of the sub-channels, the period to transmit one data symbol is inflamed and it decrease the effect of the multi-path and fading effects of wireless channels on the OFDM system performance.

In the practical, this system required large number of carriers to transmit the data. When these carriers superpose on each other, it will creates a very large peak to average power ratio (PAPR). A major drawback of OFDM at the transmitter side is the high peak-to-average power ratio (PAPR) of the transmitted signal. High peaks of OFDM signals occur when the sinusoidal signals of the subcarriers are added constructively. These high peaks necessitate using larger and expensive linear power amplifiers. Since high peaks occur irregularly and infrequently, this means that power amplifiers will be operating inefficiently. A large number of solutions have been proposed to solve the PAPR problem in OFDM. Which can be reduced using several techniques such as clipping and filtering, coding, selective mapping (SLM), partial transmit sequence (PTS) and peak cancellation (PC)[4]. PAPR reduction techniques vary according to the needs of the system and are dependent on various factors. PAPR reduction capacity, increase in power in transmit signal, loss in data rate, complexity of computation and increase in the bit-error rate at the receiver end are various factors which are taken into account before adopting a PAPR reduction technique of the system. OFDM is a

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robust transmission technique to combat the influence of wireless fading channels. However, OFDM suffers from high peak-to-average power ratio (PAPR) that significantly reduces the efficiency of the high power amplifier (HPA)[8]. To reduce this, many approaches have been proposed to reduce the PAPR, among which the pre-distortion approach such as clipping, is an efficient one [1]. Peak cancellation (PC) is known as one of the simplest peak-to-average power ratio (PAPR) reduction techniques that are applicable to various communications standards. The salient advantage of PC is its ease of hardware implementation, but it induces in-band distortion and out-of-band radiation. In order to restrict the amount of distortion within an acceptable level, it is critical to carefully design the cancelling pulses as well as the envelope threshold over which PC is applied [3].

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II. PAPR IN OFDM

A.Orthogonal Frequency Division Multiplexing:

Orthogonal frequency division multiplexing is a special case of frequency division multiplexing. OFDM is the combination of modulation and multiplexing .Is a multicarrier modulation scheme. Is the method of encoding digital data on multiple carrier frequencies. In modulations, information is mapped on to changes in frequency, phase or amplitude (or a combination of them) of a carrier signal. Multiplexing deals with allocation/accommodation of users in a given bandwidth (i.e. it deals with allocation of available resource). OFDM is a combination of modulation and multiplexing. In this technique, the given resource (bandwidth) is shared among individual modulated data sources. Normal modulation techniques (like AM, PM, FM, BPSK, QPSK, etc.) are single carrier modulation techniques, in which the incoming information is modulated over a single carrier. OFDM is a multicarrier modulation technique, which employs several carriers, within the allocated bandwidth, to convey the information from source to destination. Each carrier may employ one of the several available digital modulation techniques (BPSK, QPSK, QAM etc.).

B. Peak to Average Power Ratio:

Presence of large number of independently modulated sub-carriers in an OFDM system the peak value of the system can be very high as compared to the average of the whole system. This ratio of the peak to average power value is termed as Peak-to-Average Power Ratio. Coherent addition of N signals of same phase produces a peak which is N times the average signal. The PAPR is the ratio of maximum power of a sample in a given OFDM transmit symbol to the average power of that OFDM symbol. When in a multicarrier system the different sub-carriers are out of phase with each other, then PAPR occurs. There are large number of independent modulated subcarriers in an OFDM system multicarrier concept, due to those subcarrier in an OFDM, the peak value of the OFDM system can be very high as compared to the average value of the whole system. This ratio of the peak to average power value is termed as peak to average power ratio [8],

$$PAPR=max \ |x(t)|2E[|x(t)|2]$$

Where E [.] depicts Expectation operator.

In OFDM System Model, it can be noted that the input transmit signals are modulated first using either PSK or QAM i.e. Phase Shift Keying or Quadrature Amplitude Modulation and then undergo IFFT (Inverse Fast Fourier Transform) operation at the transmitter end. The orthogonal sub-carriers are produced at the transmitter side. These transmitted signals can have high peak values in time domain and these high peak values are referred to as high Peak to Average Power Ratio, in OFDM Systems as compared with Single carrier systems. The high PAPR is a result of summation of sine waves and non-constant envelope. The deleterious effect of High PAPR is that it decreases the Signal to Quantization Noise Ratio of ADC and DAC's, while lowering the performance of power amplifier. Therefore, RF power amplifiers needs to be operated in very large linear region, else ways the signal peaks will get entered into non-linear region and will cause distortion. So there are number of PAPR reduction techniques. The PAPR of OFDM signals x(t) is defined as the ratio between the maximum instantaneous power and its average power,

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PAPR= PPEAKPAVERAGE=10log10 max |X(n)|2E|X(n)|2

Where P_{peak} represents peak output power, means average output power. E[·] denotes the expected value, Xn represents the transmitted OFDM signals which are obtained by taking IFFT operation on modulated input symbols Xk .

The instantaneous output of an OFDM system often has large fluctuations compared to traditional single-carrier systems. This requires that system devices, such as power amplifiers, A/D converters and D/A converters, must have large linear dynamic ranges. If this is not satisfied, a series of undesirable interference is encountered when the peak signal goes into the non-linear region of devices at the transmitter, such as high out of band radiation and inter-modulation distortion. PAPR reduction techniques are therefore of great importance for OFDM systems. Also due to the large fluctuations in power output the HPA (high power amplifier) should have large dynamic range. This results poor power efficiency [2].

III. PEAK CANCELLATION IN OFDM

For reducing PAPR, simple techniques are used such as clipping and filtering (CAF), and peak cancellation (PC), which have much lower complexity, can be considered as more realistic approaches from the viewpoint of practical implementation. These techniques essentially introduce nonlinear operations so that distortions are inevitable. Given that some degree of distortion is generally allowed for the transmitted signals, such techniques are very attractive. The major drawback of CAF is the peak regrowth caused by the filtering effect, and the amount of regrowth is generally intractable. Although PAPR regrowth can be somewhat alleviated by iterative use of CAF, the resulting complexity will be increased several fold because of the duplicated functional block [1].Peak cancellation is a class of peak-to-average power ratio (PAPR) reduction techniques for orthogonal frequency division multiplexing (OFDM). The above fig. shows the parallel data signal is then converted in IFFT first then add cyclic prefix of given input signal then this parallel signal get converted in serially and the extra peak is cancelled by peak cancellation method and finally get the better output signal. It can control the PAPR and out-of-band radiation simultaneously at the cost of additional interference. Orthogonal frequency division multiplexing (OFDM) is a robust transmission technique to combat the influence of wireless fading channels [5].

However, OFDM suffers from high peak-to- average power ratio (PAPR) that significantly reduces the efficiency of the high power amplifier (HPA). To alleviate this, many approaches have been proposed to reduce the PAPR, among which the pre-distortion approach such as clipping, is an efficient one. Clipping cancels the signal peak by adding a scaled pulse function, at the cost of out-of-band radiation due to the infinite frequency response of the pulse function. Therefore, filtering should be combined at the cost of peak regrowth.

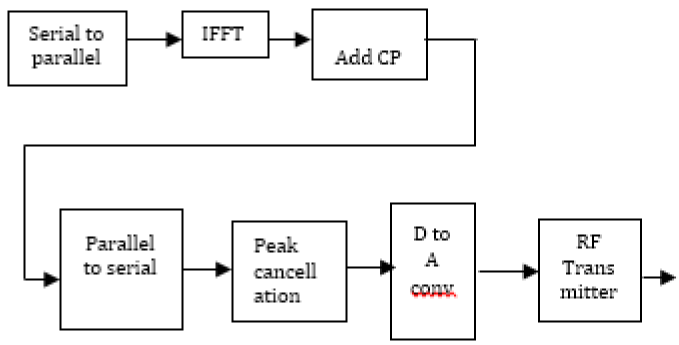

Fig.1: Peak Cancellation In OFDM

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To control the PAPR and out-of-band radiation simultaneously, repeated clipping and filtering (RCF) is proposed in with a high complexity. To simultaneously make a better trade-off among PAPR, out-of-band radiation and computational complexity, peak cancellation is proposed as a candidate of clipping-based techniques. It introduces designed windowing function, with finite response in both time and frequency domains, to replace the original pulse function in clipping. In this case, peak cancellation will not cause severe out-of-band radiation, thus saving the complexity for RCF. Peak cancellation will introduce additional distortion to the transmitted signals, thus degrading the system performance.

IV. SIMPLIFIED BLOCK DIAGRAM OF PC PROCESS

A basic diagram of the PC process considered in this work is sketched in Figure 1. Its principle is to generate cancelling pulses at the time instants where the peaks higher than the predetermined threshold are found. The generated pulses are linearly scaled and rotated with appropriate phase shift such that after their addition the original signals have the peaks reduced to the threshold [3], [5].The principle of PC is to generate cancelling pulses at the time instances where the peaks higher than the predetermined threshold γ are found and to subtract them from the original signal.

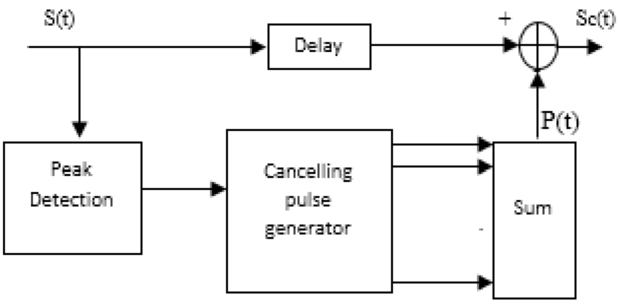

Fig. 2: Simplified block diagram of PC process

Therefore according to diagram the equation of peak cancellation can be written as,

$$S_c(t) = S(t) - \underbrace{\sum_{i=1}^{N_p(\gamma)} p_i(t - t_i)}_{p(t)}$$

Where *pi (t)* denotes the cancelling pulse corresponding to the i th peak with an appropriate time shift such that *pi (t)* has a peak at $t = 0$, and *p (t)* is the sum of all the cancelling pulses generated within one OFDM symbol [6].

V. CREST FACTOR

Crest factor is a measure of a waveform, such as alternating current or sound, showing the ratio of peak values to the effective value. In other words, crest factor indicates how extreme the peaks are in a waveform. The peak cancellation method of CFR reduces the peak to average power ratio (PAPR) of a signal by subtracting spectrally shaped pulses from signal peaks that exceed a specified threshold. The cancellation pulses are designed to have a spectrum that matches that of the CFR input signal and therefore introduce negligible out-of-band interference. In general, the CFR input signal and cancellation pulses are complex, and the peak search is carried out on the signal magnitude. Because the signals are complex, each cancellation pulse must be rotated to match the phase of the corresponding signal peak. The peak magnitude of a given cancellation pulse is set equal to the difference between the

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corresponding signal peak magnitude and the desired clipping threshold [7]. This method reduces the signal peak magnitudes to the threshold value while preserving the signal phase. Most practical CFR solutions are based in principle on subtracting a correction signal from the original signal, similar manner in PC-CFR technique, the peaks are detected and then they are processed to form the cancellation signals in order to be subtracted from the original signal.

VI. ADJACENT CHANNEL LEAKAGE RATIO (ACLR)

Adjacent Channel Leakage Ratio (ACLR) is defined as the ratio of the transmitted power to power in the adjacent radio channel .both power are measured after a receiver filter. This is what was formally called as adjacent channel power ratio. As the occurrence of the peaks higher than the threshold becomes a rare event, the out- of-band power added to the original signal should be relatively low. Consequently, the integer *n* need not be necessarily very large to meet the spectral requirement. If we assume that the original signal has sufficiently low out of- band level, the ACLR of the PC output signal is determined exclusively by the cancelling pulses that are added to the input signal. Nevertheless, since the amplitude of each cancelling pulse kernel is adjusted to the observed peak level, the out-of band power caused by the cancelling pulses is related to the statistical distribution of the peaks [9].

VII. ERROR VECTOR MAGNITUDE

EVM is the ratio of the average of the error vector power (Perror) to the average ideal reference vector power (Pref). Error vector magnitude (EVM) is a measure of modulation quality and error performance in complex wireless systems. It provides a method to evaluate the performance of software-defined radios (SDRs), both transmitters and receivers. It also is widely used as an alternative to bit error rate (BER) measurements to determine impairments that affect signal reliability. (BER is the percentage of bit errors that occur for a given number of bits transmitted.) EVM provides an improved picture of the modulation quality as well. In wireless transceivers, EVM is a commonly adopted measure of the in-band distortion and out of band radiation.

VIII. CONCLUSION

The main objective of this paper is to study the overview of peak cancellation method. Hence the problem of the power amplifier to move to the saturation region during the encountering of high peak signals can be overcome. The defective issue of OFDM technology is the PAPR problem, so it is very important to improve the high PAPR issue of OFDM signal. Most of the reducing technology for high PAPR needs the complexity calculation. More than 5dB of PAPR reduction can be achieved with this reducing crest factor algorithm.

In this paper we have to studied the about the overall of peak cancellation method. It is a one of the simplex technique to reducing PAPR. It is more efficient than amplitude clipping and filtering method. As well as it achieve better PAPR performance, EVM performance and ACLR performance than clipping and filtering method. This method is used for In-band distortion and out-of band radiation.

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