PERFORMANCE ANALYSIS FOR DIFFERENT VALUES OF SUB-CARRIERS USING ADVANCED APPROACH FOR PAPR REDUCTION IN OFDM SYSTEMS

[1]Nutan Kumari, [2]Simarpreet Kaur

[1]M-Tech Student, [2]Assistant Professor
Deptt.of Electronics & Communication Engg.BBSBEC, Fatehgarh Sahib,India
Email: [1]nutanbedi@yahoo.in, [2]simarpreet.kaur@bbsbec.ac.in

Abstract— In the modern era, wireless science has acquired a lot of attention due to its efficient communication. The recent OFDM modulation format is being adopted for latest wireless and telecommunication standards. OFDM is a type of radio signal modulation format. There are plentiful advantages that are being offered by the OFDM systems such as its high spectrum efficiency, less sensitivity to time synchronization errors and its robustness against Inter Symbol Interference. But, one of the conditions that affect the performance of OFDM Systems is elevated PAPR. In this paper, an advanced approach is discussed for reducing the PAPR effect and the system performance is analyzed for different values of sub-carriers.

Keywords—OFDM, CCDF, PAPR, ISI, WLAN.

I. INTRODUCTION

Wireless technology has become an intensive research area for engineers to provide smooth communication. One of the popular modulation formats used by wireless communication systems is Orthogonal Frequency Division Multiplexing. OFDM is the most promising technique for high data rate transmission [3]. It is a popular modulation approach for high speed mobile communication because of its manifold features such as high spectrum efficiency i.e. efficient utilization of available bandwidth [1], resilience to Inter-symbol Interference and Inter frame Interference [6], its ability to combat multipath fading [6] and ability to easily adapt severe channel conditions [7]. The bountiful applications of OFDM systems includes its uses in Digital Audio Broadcasting (DAB), Digital Television DVB-T/T2 (Terrestrial), DVB-C2 (Cable), Wi-Max and in LTE Advanced 4G mobile phone standards[7]. It appears to be the most promising candidate for 4G mobile communications. But, one of the limitations of OFDM system is high PAPR i.e. Peak to Average Power Ratio. As this requires linear transmitter circuitry. this elevated effect of PAPR causes degradation in system efficiency. It further causes distortion in signal and this signal distortion introduces intermediating effect among sub-carriers and resulting in out of band radiation. Several techniques are used to reduce the effect of high PAPR. These techniques are broadly classified in two categories namely Signal Scrambling Techniques and Signal Distortion Techniques. The PAPR reduction technique is selected as per the system requirements. The assembling of this paper is as follows:-section 2 gives explanation to PAPR of OFDM signal. Section 3 explains various PAPR reduction techniques; section 4 gives explanation about the proposed work. Section 5 gives us Simulation Results. Section 6 sums up with the conclusion part.

II. PAPR OF OFDM SIGNAL

PAPR stands for Peak To Average Power Ratio. It is observed in OFDM Systems. PAPR is the relation between the maximum power of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol. PAPR appears to be one of the stumbling blocks in wireless communication systems, For an OFDM Signal with N sub-carriers, the maximum value of PAPR can be calculated using [4] equation:-

PAPR= 10 log 10 N (dB) ----(1)

The PAPR (in dB) of transmitted OFDM signal is defined as [1]:-

$$PAPR(x) = \frac{\max \left| x(t) \right|^2}{E[\left| x(t) \right|^2]} \quad \text{----- (2)}$$

Where E[.] depicts Expectation operator.

The time domain signal is expressed as [1]:-

$$\frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_K \, e^{j2\Pi f_n t}, 0 < t < T \quad \text{----- (3)}$$

The CCDF i.e. Complementary Cumulative Distribution Function is the measure by which the PAPR effect is calculated. The PAPR effect increases with increase in the number of sub-carriers. OFDM is a multiplexing technique that divides the high bit stream into many slowly modulated narrow band sub-carriers [7]. The sub-carriers frequencies are selected in such a manner that sub –carriers appear to be orthogonal to each other, meaning that the cross-talk between the sub-channels gets eliminated and the requirement of Inter-carrier guard band is not needed [2].

III. PAPR REDUCTION TECHNIQUES

Different PAPR reduction techniques are discussed in this paper which are used for lowering the upraised effect of PAPR in OFDM systems. There are numerous techniques which have been studied in literature related to this field which can be used to reduce the PAPR effect such as SLM, PTS, Tone Reservation, Tone Injection, Clipping and filtering and Interleaving technique.

Clipping and Filtering Technique:- Clipping and Filtering technique is the extensively used approach for PAPR reduction. It is one of the simplest techniques available so far as it basically clips the part of the signal that exceeds the allowed region [ ]. The condition for amplitude clipping is [5]:-

$$C(X) = \begin{cases} x, & |x| \le A \\ A, & |x| \ge A \end{cases} \quad \text{-----(4)}$$

Where A is a positive real number, which represents clip level. Broadly, clipping is performed at the transmitter end and receiver needs to estimate the clipping operation [5]. Clipping operation occurs per symbol and the receiver has to estimate two criterion i.e. location and size of the clip [5]. The disadvantages of this clipping technique are that it introduces both in-band distortion and out of band radiation for the OFDM Signals which further accounts to degradation in spectral efficiency and BER [5]. The clipping and filtering technique is very productive in removing the components of the expanded spectrum. The filtering technique can reduce the spectrum growth and also helps in making the signal smooth. The iterative clipping technique can reduce the PAPR without expanding the spectrum [1]. But, by using the iterative clipping and filtering technique, the system computational complexity increases.

Companding Technique:- The companding transform is a technique used for PAPR reduction. The term Companding is composed by two words i.e. Compression and expansion. In Companding transform, the compression operation is performed at the transmitter end after the IFFT process i.e Inverse Fast Fourier Transform process. The technique reduces the PAPR effect in the OFDM signal. By the implementation of this technique, the gain of the signal increases and the complexity of the system is reduced. The expansion operation of the Companding technique is performed at the receiver end. At the receiver end, the received signal is to be expanded by the Inverse Companding Transform before it is sent to the FFT i.e. Fast Fourier Transform process block.

IV. PROPOSED WORK

In OFDM systems, one of the major drawbacks observed is the upraised value of PAPR. This elevated value of PAPR introduces distortion effect and this affects the performance of the

system. PAPR reduction techniques can be different as per the requirements of the system. Earlier used approaches were used to lessen the effect of high PAPR, but in this paper , an advanced approach for reducing the PAPR effect is studied. This advanced approach comprises of clipping and filtering technique along with the companding technique. This combined approach reduces the PAPR effect to a large extent. The Companding technique allows signals with large dynamic range to be transmitted over facilities that have smaller range capability. With the use of this advanced approach, the system complexity is decreased, the gain of the signal is increased and the PAPR effect is reduced to a large extent.

V. SIMULATION RESULTS

In this section, Matlab simulations are used to calculate the Peak to Average Power Ratio reduction capability of the information. The performance analysis is done for different values of sub-carriers such as 128 sub-carriers, 256 sub-carriers and 512 sub-carriers. The CCDF Vs PAPR comparison graph plots are shown in this section. The graphs depict the comparison between original signal and the proposed approach i.e. the advanced approach which makes use of clipping and filtering technique along with Companding technique.

For 128 sub-carriers

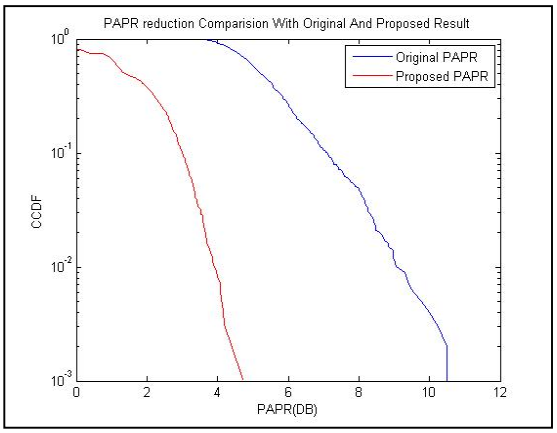

Fig1 CCDF Vs PAPR comparison Plot for Original OFDM Signal and the proposed technique at 128 sub-carriers.

The value of the original signal is 10.5021, whereas the value for the proposed technique is 4.7089.

For 256 sub-carriers

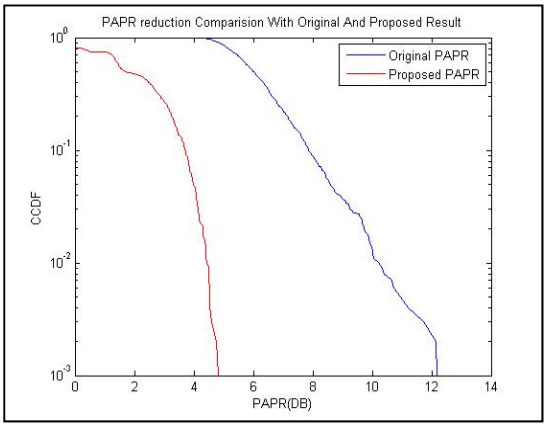

Fig 2 CCDF Vs PAPR comparison Plot for Original OFDM Signal and the proposed technique at 256 sub-carriers.

The value of the original signal is 12.1655, whereas the value for the proposed technique is 4.8329.

For 512 sub-carriers

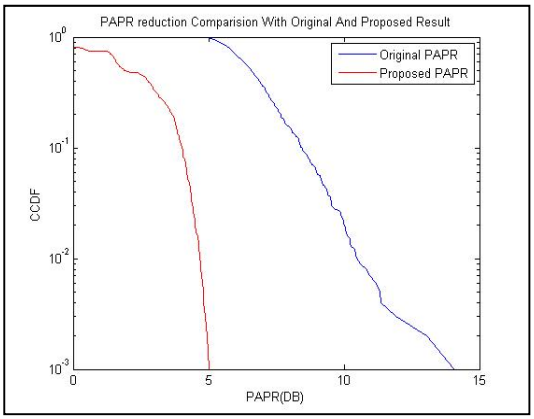

Fig 2 CCDF Vs PAPR comparison Plot for Original OFDM Signal and the proposed technique at 512 sub-carriers.

The value of the original signal is14.0488, whereas the value for the proposed technique is 5.0326

VI. CONCLUSION

OFDM i.e. Orthogonal Frequency Division Multiplexing is a popular modulation technique which divides the high data rate stream into closely spaced sub-carriers at a low modulation rate. OFDM systems appear to be an important part of the wireless communication field. It can be concluded that the advanced approach used in

this paper tried to reduce the PAPR effect to a great extent. It has also been observed that the PAPR effect increases with the increase in the number of sub-carriers and the PAPR effect is reduced with less number of sub- carriers.

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