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PAPR REDUCTION IN OFDM SIGNALS USING CLIPPING AND FILTERING

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ABSTRACT

Orthogonal frequency division multiplexing (OFDM) has been recently seen more popularity in wireless applications. Orthogonal Frequency-Division Multiplexing (OFDM) is one of the technologies considered for 4G broadband wireless communications due to its robustness against multipath fading and relatively simple implementation compared to single carrier systems. One major generic problem of OFDM technique is high peak to average power ratio (PAPR) which is defined as the ratio of the peak power to the average power of the OFDM signal. A trade-off is necessary for reducing PAPR with increasing bit error rate (BER), this paper deals with reduction of PAPR in OFD.

Keywords— Orthogonal Frequency Division Multiplexing (OFDM) and Peak to Average Power Ratio (PAPR).Bit Error rate (BER), Complementary Cumulative Distribution Function (CCDF).

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I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) has been recently seen rising popularity in wireless applications. For wireless communications, an OFDM-based system can provide greater immunity to multi-path fading and reduce the complexity of equalizers. Now OFDM have been included in digital audio/video broad-casting (DAB/DVB) standard in Europe, and IEEE 802.11, IEEE 802.16 wireless broadband access systems, etc.

OFDM works by splitting the radio signal into multiple smaller sub-signals which are then transmitted simultaneously at different frequencies to the receiver. The basic idea is using a large number of parallel narrow-band subcarriers instead of a single wide-band carrier to transport information. This method is very easy and efficient in dealing with multi-path and robust again narrow-band interference. These sub-carriers (or sub-channels) divide the available bandwidth and are sufficiently separated in frequency (frequency spacing) so that they are orthogonal.[1]

II. AMPLITUDE CLIPPING AND FILTERING

The clipping is the simplest method of PAPR reduction. Clipping limits the maximum amplitude of OFDM signal to a pre-specified level. The implementation of clipping is relatively easy but it has following drawbacks.

(a) It causes in-band signal distortion, resulting in BER performance degradation.

(b) It also causes out-of-band radiation, which imposes out-of-band interference signals to adjacent channels. The out-of-band radiation can be reduced by filtering, but the filtering may affect high-frequency components of in-band signal (aliasing) when the clipping is performed with the Nyquist sampling rate.

(c) Filtering after clipping can reduce out-of-band radiation at the cost of peak re-growth. The signal after filtering operation may exceed the clipping level specified for the clipping operation.

III. PAPR REDUCTION TECHNIQUES.

Several PAPR reduction techniques are available in the literature. These methods are basically divided in four

categories:

(I) Signal Distortion.

These methods reduce the PAPR by distorting the OFDM signal non-linearly. The methods like clipping and filtering, peak windowing, and non-linear companding are the example of these techniques.

(II) Coding Method.

The coding methods employed some error correcting codes for the PAPR reduction. These methods applied before the generation of OFDM signal (before IFFT). When N signals are added with the same phase, they produce a peak power, which is N times the average power. The basic idea of all coding schemes for the reduction of PAPR is to reduce the occurrence probability of the same phase of N signals.

(III) Probabilistic (Scrambling) Techniques.

The probabilistic methods are based on scrambling of each OFDM symbol with different scrambling sequences and selecting that sequence which gives smallest PAPR. While it does not suffer from the out-of-band power, the spectral efficiency decreases and the complexity increase as the number of subcarriers increases.

(IV) Pre-distortion Methods.

The pre-distortion methods are based on the re-orientation or spreading the energy of data symbol before taking IFFT. The pre-distortion schemes include DFT spreading, pulse shaping or pre- coding and constellation shaping. The methods like Tone Reservation (TR) and Tone Injection (TI) are the example of constellation shaping schemes.

IV. PROPOSED CLIPPING AND FILTERING SCHEME

As the major spotlight of this paper is to reduce PAPR, so, in this simulation, we have trade-off between PAPR reductions with BER increment. Very little amount of BER increment is desirable

Considering the limitation that Filtering after clipping can reduce out-of-band radiation at the cost of peak re-growth. The signal after filtering operation may exceed the clipping level specified for the clipping operation.

Work showed that if clipped signal passes through a Composed filter (FIR based HPF) before passing a LPF to reduce out-of- band radiation, then it causes less BER degradation with medium amount of PAPR reduction than an existing method. Considering this concept, we have designed another scheme for clipping & filtering method where clipped signal passes through a Composed filter (IIR based BPF) before passing a LPF, then it causes a little bit more BER degradation but more amount of PAPR reduction than our previous work. In this simulation we are clipping the signal above the 70 % threshold level to get the better result of PAPR. [2]

V. OVERVIEW OF PAPR

PAPR is an one of the important factor in the design of both high power amplifier (PA) and digital-to-analog (D/A) converter, for generating error-free (minimum errors) transmitted OFDM symbols. So, the ratio of peak power to average power is known as PAPR.

$$\mathrm{PAPR} = \frac{\text{Peak\_Power}}{\text{Average\_Power}}$$

The PAPR of the transmitted signal is defined as,

$$\mathrm{PAPR}[x(t)] = \frac{\max_{0 \le t \le NT} |x(t)|^2}{P_{av}}$$

Where, Pav is the average power of and it can be computed in the frequency domain because Inverse Fast Fourier Transform (IFFT) is a (scaled) unitary transformation.

To better estimated the PAPR of continuous time OFDM signals, the OFDM signals samples are obtained by L times oversampling. L times oversampled time domain samples are LN point IFFT of the data block with (L-1) N zero-padding. Therefore, the oversampled IFFT output can be expressed as

$$x[n] = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k \; e^{j2\pi nk/LN} \qquad 0 \le n \le NL-1$$

VI. FIGURE AND TABLE

1. Block Diagram of Proposed Clipping & Filtering Scheme.

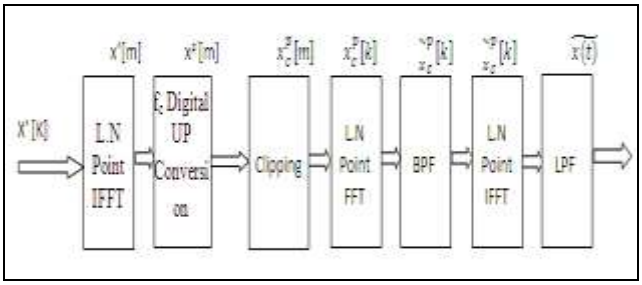

Fig.1 Block Diagram of Proposed Clipping & Filtering Scheme.

Above Fig.1 show block diagram for PAPR reduction using clipping and filtering method. Here we clip the OFDM signal above the some threshold level and observed the PAPR output for same.

2. Frequency Spectrum of band limited OFDM signal for,
   Enter total frequency range (in MHz) = 2
   Enter Cutoff frequency (in MHz) = 2
   Total of carriers= 16

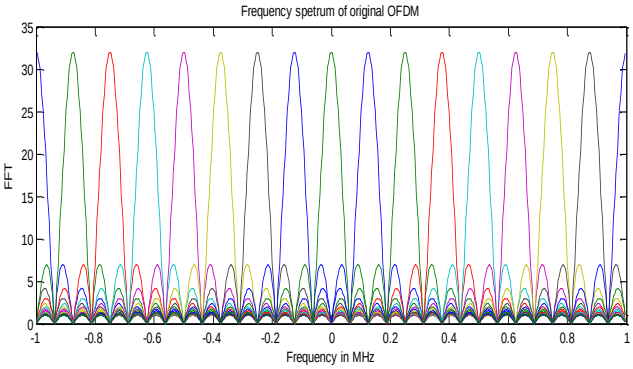

Fig.2 Frequency spectrum of band limited OFDM signal

3. PAPR of original OFDM signal and PAPR of Clipped and filtered OFDM signal.

Sr. No.	Alphabet size	Transmitted symbols	PAPR Of Original signal(dB)	PAPR Of Clipped signal(dB)
1	2	128	3.7924	2.5837
2	4	128	4.7744	2.7880
3	8	128	5.7691	2.6043
4	16	128	5.2413	2.7596

Table 1. PAPR values for original and clipped OFDM signal.

4. BER for number of transmitted symbols (Power of 2) =128

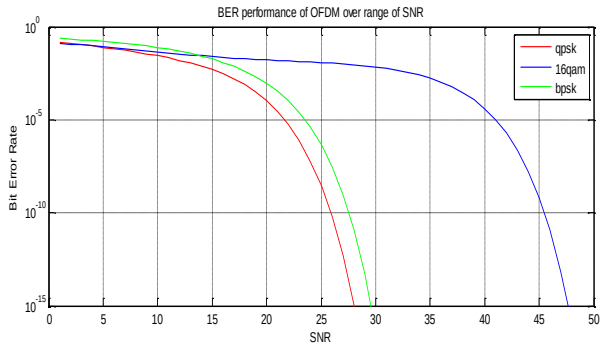

Fig.3 BER performance of OFDM over range of SNR.

VII. CONCLUSION

In this paper we run the simulation for various Alphabet size and Transmitted symbols, in this simulation total number of carrier are 16. In simulation we compare PAPR value of original OFDM signal and PAPR value of clipped OFDM signal. We found that we get a better result for clipped OFDM signal as compare to original OFDM signal. Also we plot the BER performance of OFDM over range of SNR.

REFRENCES

[1] Xiaodong Zhu, Wensheng Pan, Hong Li, and Youxi Tang., IEEE TRANSACTIONS ON COMMUNICATIONS,61, 1891-1901, 2013 .

[2] Md. Munjure Mowla1, Md. Yeakub Ali2 and Rifat Ahmmed Aoni3., International journal of Mobile Network Communications & Telematics, 4,23-34,2014.

[3] Sroy Abouty, Li Renfa, Zeng Fanzi and Fall Mangone., International Journal of Future Generation Communication and Networking, 6,2-8,2013.

[4] Jun Hou, Jianhua Ge, Dewei Zhai, and Jing Li., IEEE TRANSACTIONS ON BROADCASTING,,56,258-262,2010.

[5] Richard Van Nee and Ramjee Prasad, OFDM For Wireless Multimedia Communications, Artech House Publishers, Norwood MA, 2000.

[6] Richard Van Nee and Ramjee Prasad, OFDM For Wireless Multimedia Communications, Artech House Publishers, Norwood MA, 2000.

[7] R. W. Chang, \Synthesis of band-limited orthogonal signals for multichannel data," BSTJ., pp. 1775-1797, Dec. 1996.