ISSN:0975-9646

Mousumi De et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (1) , 2014, 361-365

Evaluation of Optimized PAPR and BER of OFDM signal by using Clipping and Filtering Technique

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Abstract:-**Orthogonal Frequency Division Multiplexing (OFDM) is an emerging field of research in the field of wireless communication and finds its application where high data rate is required at low latency and better spectral efficiency. Peak to Average Power Ratio (PAPR) is the limiting factor for an OFDM system as it degrades the system performance by reducing SQNR of ADC/DAC as well as it affects the transmitter amplifier. There are many techniques to overcome the problem of PAPR like Clipping and Filtering, Coding Technique, Scrambling Technique and many more. In this paper we discussed clipping and filtering technique which is easy to implement and reduces the amount of PAPR by clipping the peak of the maximum power signal. Moreover, analysis of PAPR is given by varying different parameters. The PAPR problem is more important in the uplink since the efficiency of power amplifier is critical due to the limited battery power in a mobile terminal.**

Keywords: OFDM, PAPR, SQNR

I. INTRODUCTION

OFDM has its major benefits of higher data rates and better performance. High data rates are achieved by the use of multiple carriers and performance improvement is caused by the use of guard interval thus mitigating ISI. Apart from these basic benefits, it also increases spectral efficiency and minimizes multipath distortion.Although the use of multiple carriers is quite handy, it is accompanied by a lot of implementation problems like major one being the high Peak to Average Power Ratio (PAPR) of OFDM systems. It is given as:

$$papr = \frac{\max[x(t)x^*(t)]}{E[x(t)x^*(t)]} \quad (1)$$

Where x(t) denotes the pass band signal whose PAPR is to be calculated. Expressing in deciBels,

$$papr_{dB} = 10\log_{10}(papr) \quad (2)$$

The subsystems used in communication are linear over a limited range. The more frequently used is HPA at the transmitter end to increase the transmitted power. However, the OFDM receiver detection is degraded severely by the use of non-linear amplfiers so HPA should not be used at full capacity but should be backed off to the limited linear range . PAPR limits DAC and ADC at transmitter and receiver end respectively. It increases Signal to Quantization Noise Error; this has to be increased to tackle the quite high peak powers. One way to minimize is the use of logarithmic quantizer which reduces it to some extent by smaller step sizes for higher amplitudes.This is good as the probability of getting higher power decreases as the power is increased. This probabilistic behavior is discussed in detail in the work to follow. However for the best performance, more advanced ways are used.

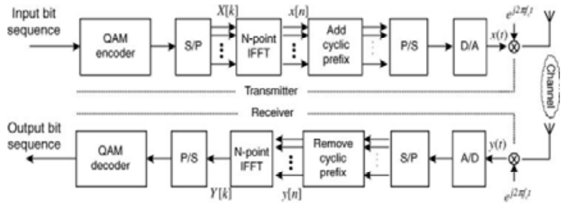

Figure 1:-Block diagram of OFDM system.

II. PAPR OF SINGLE SINEWAVE

Consider a sinusoidal signal x(t)=sin(2πft) having the period T. The peak value of the signal is max[$x(t)x^*(t)$]=+1. The mean square value of the signal is,

$$E[x(t)x^*(t)] = \frac{1}{T}\int_0^T Sin^2(2\pi ft) = \frac{1}{2} \quad (3)$$

Given so, the PAPR of a single sine tone is,

$$papr = \frac{1}{\left(\frac{1}{2}\right)} = 2 \quad (4)$$

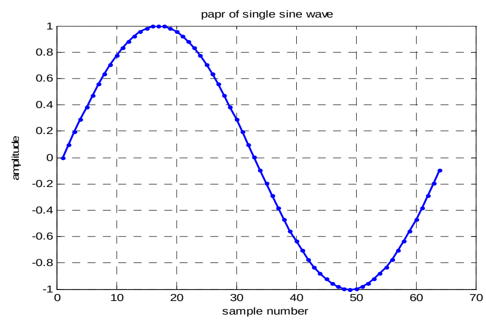

Figure 2: PAPR of a single sine tone

III. PAPR OF A COMPLEX SINUSOIDAL

Consider a sinusoidal signal $x(t) = e^{j2\pi ft}$ having the period T. The peak value of the signal is max[$x(t)x^*(t)$] = +1. The mean square value of the signal is,

$$E[x(t)x^*(t)] = \int_0^T e(4\pi ft)$$

$$= 1. \quad (5)$$

Given so, the PAPR of a single complex sinusoidal tone is, papr=1.

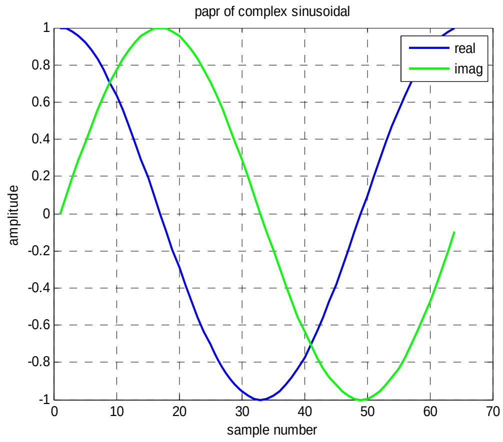

Figure 3: PAPR of a sinusoidal complex

IV. MAXIMUM EXPECTED PAPR FROM AN OFDM WAVEFORM

An OFDM signal is the sum of multiple sinusoidal having frequency separations $\frac{1}{T}$ where each sinusoidal gets modulated by independent information a_k. Mathematically, the transmit signal is,

$$x(t) = \sum_0^{K-1} a_k e^{\frac{j2kt}{T}} \quad (6)$$

For simplicity, let us assume that a_k for all the subcarriers. In that scenario, the peak value of the signal is,

$$\max[x(t)x^*(t)] = max[\sum_0^{K-1} a_k e^{\frac{j2kt}{T}} \sum_0^{K-1} a^*_k e^{\frac{-j2kt}{T}}]$$

$$= \max[a_k a_k^* \textstyle\sum_0^{K-1}\sum_0^{K-1} e^{\frac{j2\pi kt}{T}} e^{\frac{-j2\pi kt}{T}}]$$

$$= K^2. \quad (7)$$

The mean square value of the signal is,

$$E[x(t)x^*(t)] = E[\sum_0^{K-1} a_k e^{\frac{j2kt}{T}} \sum_0^{K-1} a^*_k e^{\frac{-j2kt}{T}}]$$

$$= E[a_k a_k^* \textstyle\sum_0^{K-1}\sum_0^{K-1} e^{\frac{j2\pi kt}{T}} e^{\frac{-j2\pi kt}{T}}]$$

$$= K \quad (8)$$

Given so, the peak to average power ratio for an OFDM system with K subcarriers and all subcarriers are given the same modulation is,

$$papr = \frac{K^2}{K} = K \quad (9)$$

It is reasonably intuitive that the above value corresponds to the maximum value of PAPR (when all the sub carriers are equally modulated, all the sub carriers align in phase and the peak value hits the maximum).we have used $K = 52$ sub carriers. Given so, the maximum expected PAPR is 52 (around 17dB),the cumulative distribution of PAPR from each OFDM symbol, modulated by a random BPSK signal is obtained.

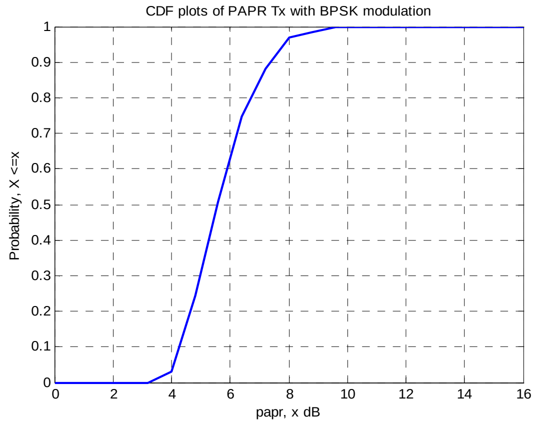

Figure 4: Cumulative distribution (CDF) plot of PAPR from a random BPSK signal

V. CLIPPING TECHNIQUE

The clipping technique employs clipping or nonlinear saturation around the peaks to reduce the PAPR. It is simple, but it may cause in-band and out-of-band interferences while destroying the orthogonal among the sub carriers. The clipping approach is the simplest PAPR reduction scheme, which limits the maximum
of transmit signal to a pre-specified level. However, it has the following drawbacks:

. Clipping causes in-band signal distortion, resulting in BER performance degradation.

. Clipping also causes out-of-band interference to adjacent channels. Although the out-of-band signals caused by clipping can be reduced by filtering, it may affect high-frequency components of in-band signal (aliasing) when the clipping is performed with the Ny-quist sampling rate in the discrete-time domain. However, if clipping is performed for the sufficiently-over sampled OFDM signals (e.g., L >4) in the discrete-time domain before a low-pass filter (LPF) and the signal passes through a band-pass filter (BPF), the BER performance will be less degraded .

VI. Simulation Results And Discussion

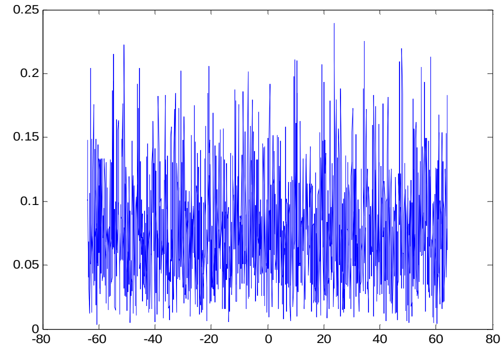

Figure 5: Simulation result of OFDM in time domain

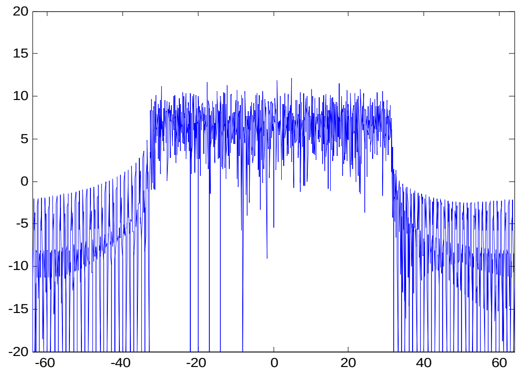

Figure 6: Simulation result of OFDM in frequency domain

Figure 5 & 6 illustrate the OFDM signal in Time domain and frequency domain respectively.

VII. Simulation Result Of Clipped OFDM Signal

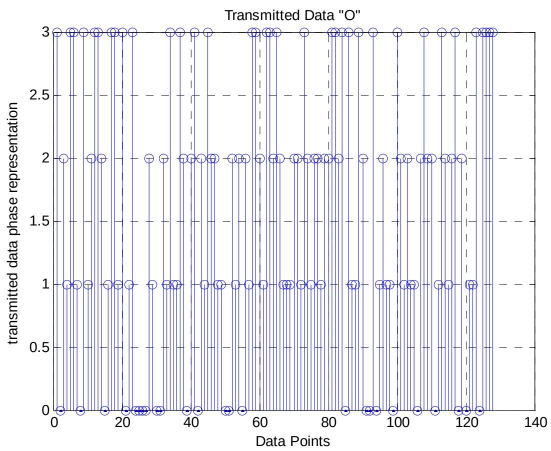

Figure 7: Transmited data

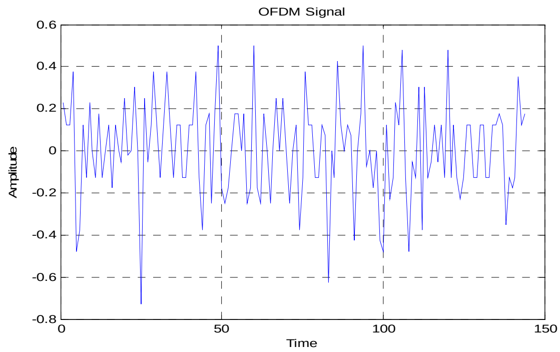

Figure 8: generated ofdm signal

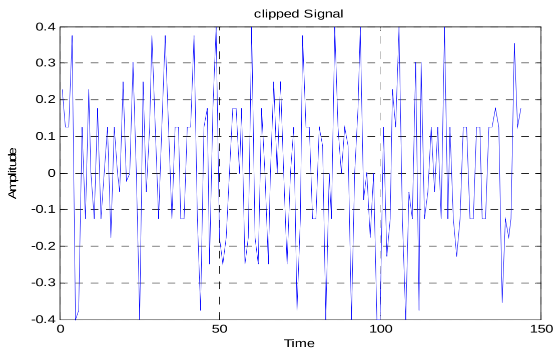

Figure 9: clipped signal

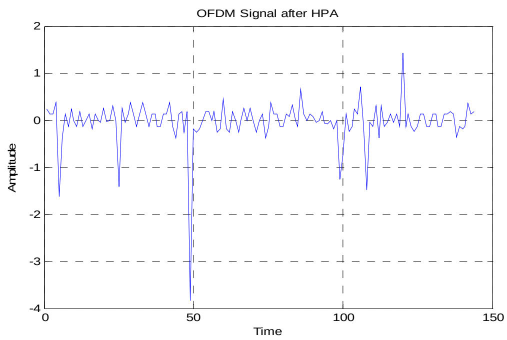

Figure 10: OFDM signal after HPA

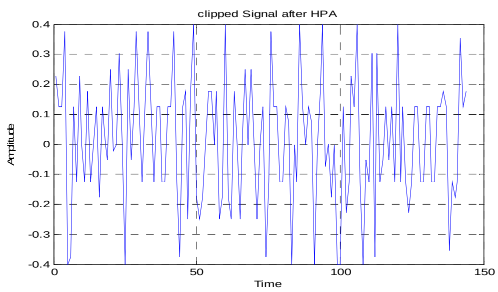

Figure 11: clipped signal after HPA

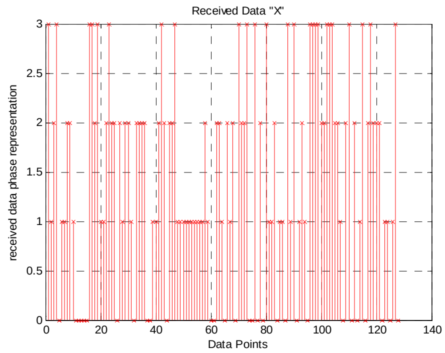

Figure 12: Received data of OFDM signal

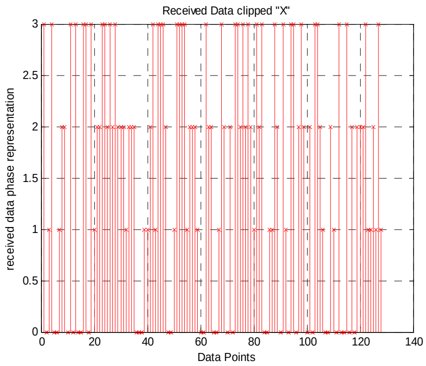

Figure 13: Received clipped data

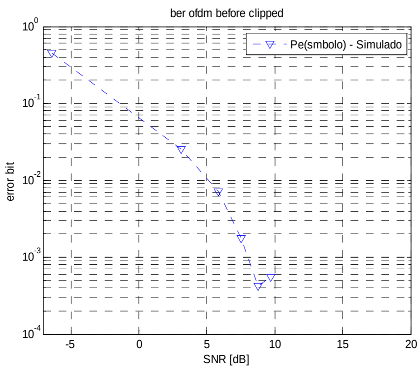

Figure 14: BER before clipping

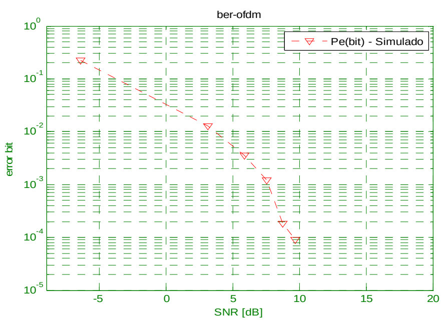

Figure 15: BER after clipping

Figure 7 illustrate a transmitted data .FIGURE 8 is generated OFDM signal.This signal is clipped and passes through HPA. At last we received clipped data.These results are shown from figure 9 to figure 13.Figure 14 & 15 are BER of that signal before clipping and after clipping respectively.

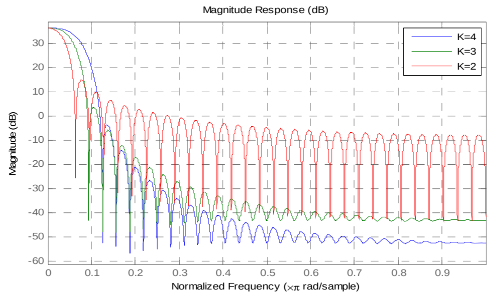

Figure 16:generated signal and filtered signal

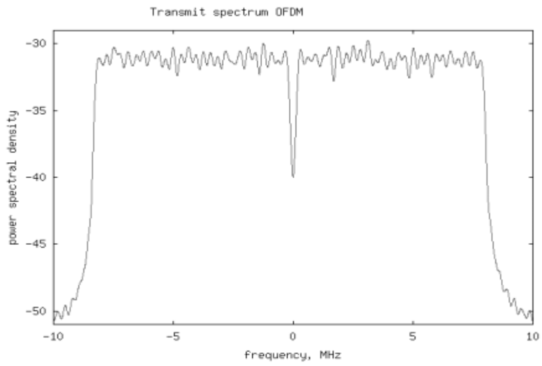

Figure 17:BER of filtered OFDM signal

Figure 16 is the filterised signal.Figure 17 is the BER of the filterised signal.This signal limits the peak amplitude in the transmitter which turns reduces the non linearity.

In First observation from the figure12 & figure 13 show OFDM signal and clipped signal with various CR's from 0.8 to 1.6respectively.
For CR =1.4 , the out-of-band noise emission power is only 16 dB lower than the signal power. This shows that filtering is necessary over the clipped OFDM signal.

After that from figure14, figure 15, figure 17 show BER of OFDM signal, clipped OFDM signal and filtered OFDM signal respectively.
From figure14 the value of BER is measured 0.032 and from figure 15 the value of BER is measured 0.042.After filtering the BER is mostly justified in figure 17 and the value of the BER is 0.064.

VIII. Conclusion

OFDM is a very attractive technique for multi carrier transmission and has become one of the standard choices for high – speed data transmission over a communication channel. It has various advantages; but also has one major drawback: it has a very high PAPR.

We have also aimed at investigating some of the techniques which are in common use to reduce the high PAPR of the system. Among the three techniques that we took up for study, we found out that Amplitude Clipping and Filtering results. In this article clipping method of reduction of PAPR is analyzed and its effects are considered.

The proposed OFDM system reduces peak power by changing phase relationship of some of the OFDM symbols at the o/p of OFDM modulator. Now there is very little effect of system nonlinearity on the transmitted signal. This will result in reduced in-band and out of band noise at the receiving end. The significant reduction in in-band and out-of band noise is achieved using the proposed design on account of limiting the peak amplitudes in the transmitter which in turns reduces the nonlinearity. The only symbols transmitted with phase alteration will be responsible for BER .It is simple and effective to reduce peak power in OFDM and significantly improves the BER performance and simplifies transmitter and receiver complexity.

REFERENCES

1. Ahmed, E., W. Aziz, S. Saleem and Q. Islam,2012. Performance Analysis of OFDM System for Different Channel Lengths and Multipath Channel Taps. Advances in Electrical Engineering Systems, 1 (2): 124-128
2. G. J. Foschini, "Layered space–time architecture for wireless communication in a fading environment when using multiple antennas," Bell Labs Syst. Tech. J., vol. 1, p. 41–59, Autumn 1996.
3. H.Taub, D. L. Schilling, G.Saha, *"Taub's Principles of Communication Systems"*: Tata McGraw Hill, 2008.
4. T. S. Rappaport, *"Wireless Communication: Principles and Practice"*: 2nd Edition, Prentice Hall, 2002.
5. R. O"Neil, L. B. Lopes, "Envelope Variations and Spectral Splatter in Clipped Multicarrier Signals", *Proc. IEEE PIMRC '95,* Toronto, Canada, September 1995.
6. X. Li, L. J. Cimini, Jr., "Effect of Clipping and Filtering on the Performance of OFDM", *IEEE Commun. Lett.,* Vol. 2, No. 5, May 1998.
7. J. Armstrong, "Peak – to – Average Power Reduction for OFDM by Repeated Clipping and Frequency Domain Filtering", *Elect. Lett.,* Vol. 38, No. 8, February 2002.