IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 4, November 2012)

A Concatenated Companding and SLM Technique for PAPR Reduction

Pankaj Shrotriya
pankaj.shrotriya1@gmail.com

Deepak Sant
deepaksant12@gmail.com

Abstract – **This paper presents a novel method for reducing PAPR (peak to average power ratio) in OFDM. Although there are several methods for PAPR reduction, but they are effective only for certain conditions. In proposed algorithm we elucidate the concatenation of SLM (Selective Mapping) and companding techniques.**

Keywords – **PAPR, OFDM, SLM, Companding.**

I. INTRODUCTION

Multicarrier modulation is one technique that provides us the desired demands of high data rates. Orthogonal Frequency Division Multiplexing (OFDM) is a form of multicarrier modulation that can be seen either as modulation technique or a multiplexing scheme. OFDM uses the Inverse Fast Fourier Transform (IFFT) operation to generate a large number of sub-channels that are orthogonal. It is already used in different WLAN standards (HIPERLAN 2, IEEE 802.11a), ADSL and digital video broadcasting (DVB). One significant issue within OFDM techniques is the existence of large Peak-to-Average Power Ratio (PAPR) which occurs as an impact of the coherent addition of multiple subcarrier amplitudes and phases from the system [1]. This high peak to average ratio causes nonlinearities in the transmitted signal and also degrades the power efficiency of the system.

Large PAPR may saturate the power amplifier at the transmitter that means the maximum output power of the amplifier will limit the peak amplitude of the signal and this effect will produce interference both within the OFDM band and in adjacent frequency bands. With high PAPR, the conversion of OFDM signals from A/D and D/A will be more challenging.

In general, the PAPR of OFDM signals x(t) is defined as the ratio period between the maximum instantaneous power and its average power during an OFDM symbol

$$\text{PAPR} \triangleq \frac{\max_{0\le n\le N-1} |a_n|^2}{P_{av}(a_n)}$$

Where

$$P_{av}(a_n) = \frac{1}{N}\sum_{n=0}^{N-1} E\{|a_n|^2\}$$

Where E {.} denotes the expected value.

There are some methods which have been used for PAPR reduction earlier such as clipping, coding, partial transmit sequence (PTS), selected mapping (SLM), interleaving [2][3], nonlinear companding transforms[4] [5], etc. these schemes can mainly be categorized into signal scrambling techniques, such as PTS, and signal distortion techniques such as clipping, companding techniques. The paper is structured as follows. Section II briefly describes proposed PAPR reduction techniques (SLM, Companding). Section III shows the simulation results. Section IV is a conclusions section and summarizes the main results from the paper.

II. METHODOLOGY

Selective mapping (SLM)

SLM technique is used to generate a set of data blocks at the transmitter end which represent the original information and then to choose the most favourable block among them for transmission. Let us consider an OFDM system with N orthogonal sub-carriers. A data block is a vector $X = (x_n)_N$ composed of N complex symbols x_n each of them representing modulation symbol transmitted over a sub-carrier. X is multiplied element by element with U vector $B_u = (b_{u,n})_N$ composed of N complex numbers $b_{u,n}$, u ∈ (0,1,.....U-1), defined so that $|b_{u,n}| = 1$, where |.| denotes the modulus operator. Each resulting vector $X_u = (x_{u,n})_N$ where $x_{u,n}=b_{u,n}.x_n$, produces after IDFT, a corresponding OFDM signal $s_u(t)$ given by

$$s_u(t) = \frac{1}{\sqrt{N}}\sum_{n=0}^{N-1} x_{u,n}\, e^{j2\pi n\Delta f t}, \qquad 0 \le t \le T,$$

Where T is the OFDM signal duration and $\Delta f = \frac{1}{T}$ is the sub-carrier spacing. Among the modified data blocks, the one with the lowest PAPR is selected

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 4, November 2012)

for transmission. The amount of PAPR reduction for SLM depends on the number of phase sequences U and the design of the phase sequences.

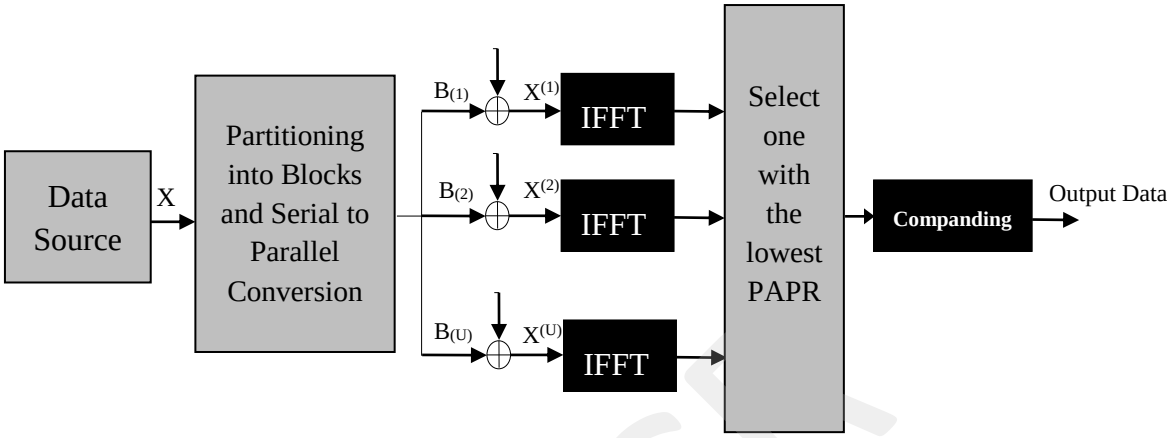

Figure1: Block Diagram of OFDM transmitter with the proposed (Concatenated SLM-Companding) technique

Companding

The compander consists of compressor and expander. Any invertible function with compression feature can be used for companding.

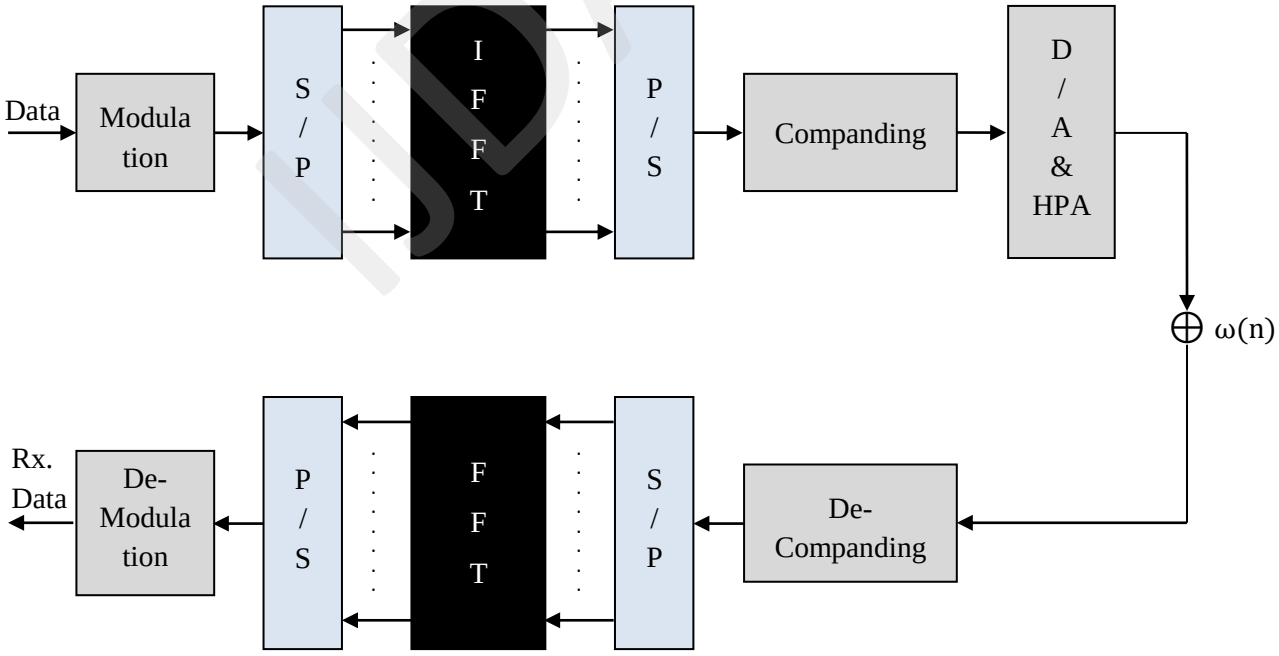

Figure2: Block diagram of companding transform

Here we apply the transformation. Because the transformation is invertible, the signal can be recovered in the receiver. First a quadrature demodulator generates the estimate of transformed signals with the aid of receiver signal level control and low pass filter. Using the inverse function of compression, the nonlinear distortion introduced by the compressor is corrected after reconstruction at the receiver with an expander.

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 4, November 2012)

Compression improves the quantization resolution of small amplitude signals at the cost of lowering the resolution of large signals. This also introduces quantization noise; however, the effect of the quantization noise due to reduction in resolution of the peaks is relatively small as the peaks occur less frequently. The compression algorithm as described by amplifies the signals of lower amplitude with the peaks remaining unchanged.

In companding the OFDM signal is compressed at the transmitter and expanded at the receiver. Compression is performed according to the well-known μ-Law viz.

$$y = V \frac{\log\left[1+\mu\frac{|x|}{V}\right]}{\log(1+\mu)}\mathrm{sgn}(x) \qquad \ldots\ldots\ldots\ldots (1)$$

Where V is the peak amplitude of the signal, and x is the instantaneous amplitude of the input signal. Decompression is simply the inverse of (1).

III. Simulation and Results

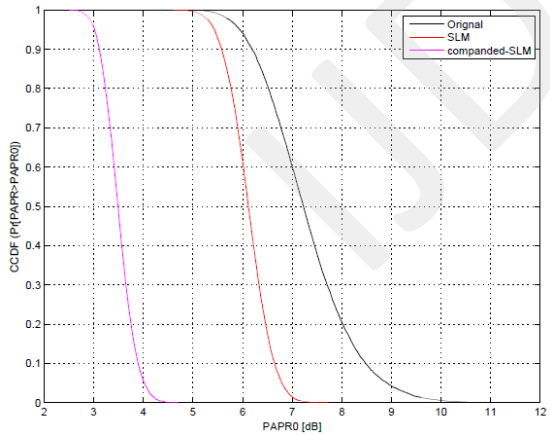

Figure3: Comparison of different techniques

IV. Conclusion

The simulation result conclude the output obtained by cascaded SLM and companding technique reduces the PAPR drastically rather than SLM technique only. Here, by using SLM hardware cost increased but at the same time PAPR reduced.

Reference

[1] Athinarayanan Vallavaraj, Brian G Stewart, David K Harrison, Francis G McIntosh, " Reduction of Peak-to-Average Power Ratio of OFDM Symbols using Phasing Schemes combined with Companding", GCC Conference (GCC), IEEE, 2006.

[2] T. Jiang and Y. Imai, "An overview: peak-to-average power ratio reduction techniques for OFDM signals," IEEE Trans. On Wireless Communications, June 2008, pp. 56-57

[3] S.H. Han, J. H. Lee, "An overview of peak-to-average power ratio reduction techniques for Multicarrier transmission," IEEE Transaction on Wireless Communication, April 2005, pp. 56-65.

[4] Xiao Huang, J H Lu, Jun Li Zhen, etal. Companding Transform for Reduction in Peak-to-Average Power of OFDM signals[J], IEEE transactions on wireless communications, VOL.03, NO.06, Nov,2004,pp. 2030-2039.

[5] Xiao bin Wang, "Reduction of peak-to-average power ratio of OFDM system using A companding technique," IEEE Transaction on Broadcasting, Vol.45, No.3, Sep 1999, pp.303-307.