International Journal of Engineering Research ISSN:2319-6890)(online),2347-5013(print)
Volume No.3 Issue No: Special 2, pp: 1- 3 22 March 2014

A PAPR Reduction technique using Golay Sequences for OFDM Systems

Lakshmi Kiran. M[1],Lalitha Kumari. D[2]
[1] PG Student (DECS), JNTU College of Engineering Ananthapuramu, Andhra Pradesh, India.
[2] Assistant Professor, Dept. of Electronics and Communication Engineering, JNTUACEA, Ananthapuramu

Abstract :- OFDM is the powerful multi carrier modulation technique. It can be used efficiently in fading environments and have many advantages. but only the drawback here is having high PAPR. In this paper, we are implementing OFDM with Golay sequences as actual input to the system and observed that OFDM signal is having low PAPR than before. Also this technique maintains low complexity and without BER loss in comparison to the competitive methods.

Keywords: BER, CCDF, FFT, Golay sequences, OFDM, PAPR.

1. Introduction:

An OFDM based communication system can be of particular interest as it has greater immunity to impulse noise, fast fades and eliminates the need for equalizers , while hardware can be realized efficiently using FFT techniques. But the problem here is while implementing OFDM with FFT, then there will be high possibility of constructively addition of many independent signals resulting high PAPR value. Due to which the system requires high power amplifiers and increasing the cost of implementation. Hence a number of approaches have been proposed to deal PAPR problem. Mainly clipping method, it takes some threshold value and just clips off the OFDM signal exceeding that value. It reduces the PAPR value but with BER loss. next method SLM (Selective Level Mapping) method in which, it consider some extra signals and mix-up with OFDM signal in a random manner in different combinations. then considering the OFDM signal having low PAPR among them. but increases the complexity.

In this paper we are using Golay encoder, which converts input data sequence to golay sequence and then apply to OFDM system. it is observed that, it would yield PAPR around 3db theoretically. practically it may be higher than this, but less than to the competitive methods.

1.1 OFDM signal, PAPR, CCDF:

OFDM, Orthogonal Frequency Division Multiplexing is a multi carrier modulation technique in which high speed data is first splitted into multiple low speed data's, which are then modulated independently with sub-channels and adding all gives the OFDM signal. this can represented by

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n e^{j2\pi n \Delta f t}; 0 \le t < NT \qquad (1)$$

PAPR can be defined as the ratio of peak power to the average power of the signal.

$$PAPR = \frac{max|x(t)|^2}{E[|x(t)|^2]} \qquad (2)$$

The Complementary Cumulative Distribution Function (CCDF) of the PAPR is one of the most frequently used performance measures of PAPR reduction techniques. The CCDF of the PAPR denotes the probability that the PAPR of a data block exceeds a given threshold. The cumulative distribution function (CDF) of the amplitude of a signal sample is given by,

$$F(z)=1-\exp(z)$$

The CCDF of the PAPR of a data block with nyquist rate sampling is derived as

$$P(PAPR>z) = 1 - P(PAPR \le z)$$
$$= 1 - F(z)^N$$
$$= 1 - (1- \exp(-z))^N$$

1.2 Golay Codes:

Golay codes are found by Marcel golay, they are primarily used for multiple error detection and multiple error correction. here these codes are used to reduce PAPR of the OFDM signal.

Generally golay codes are of two types. first one is G24(24,12,8) and second one is G23(23,11,7). In each code first co-ordinate represents number of output bits, second co-ordinate represents number of input bits and last co-ordinate represents hamming distance. The main property of golay sequence is that, the sum of its autocorrelation functions is equal to zero.

$$C_a(u) + C_b(u) = 0,\ 0<u<n.$$

Each of them is called as golay complementary sequence or simply golay sequence. They are also called as binary sequence. Because of the above property it is verified that OFDM signal with golay gives PAPR less than around 2 (i.e., 3db).

1.3 Generation of Golay Sequence:

Using Boolean functions, Davis and Jedwab determine an explicit form for generating golay sequence, such that for any permutation π of symbols (1,2,.....,m) and any c, $c_k \in Z_2^h$.

ISSN:2319-6890)(online),2347-5013(print)
22 March 2014

$$a(x_1, x_2, \cdots, x_m) = 2^{h-1} \sum_{k=1}^{m-1} x_{\pi(k)} x_{\pi(k+1)} + \sum_{k=1}^{m} c_k x_k + c \quad \text{---3}$$

is a golay sequence in Z_2^h of length 2^m.

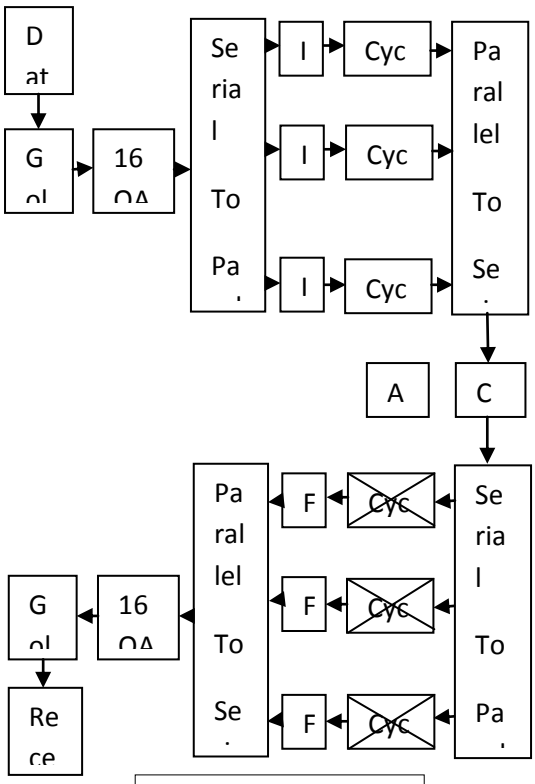

Fig.1 Block diagram

Golay sequence for input sequence can be generated with generator matrix (12*24 or 11*23 dimensions) that can be constructed by taking a sequence from the formula shown above (equation 3).

2. Implementing method:

In this section the proposed method is presented. Firstly, we study the binary case (i.e., h=1). The block diagram for the proposed method is shown in Figure 1. First golay encoder, encodes the input data to golay sequences, which are then modulated by using different techniques (we are using BPSK), then the sequence splitted into multiple parts, which are applied to different IFFT blocks followed by cyclic prefix (to remove the inter carrier interference), then adding all gives us the OFDM signal. Then that signal is transmitted which will be mix-up with the noise (AWGN) and received at the Receiver. The reverse process of transmitter gives the received signal.

3. Simulation Results and Discussion:

To evaluate the performance of the proposed method Matlab computer simulations are considered. The Parameters of this simulation are listed below in table 1.

TABLE 1. The Parameters for simulation.

Modulation	16QAM
Number of sub-carriers	52
Number of FFT points	64
Channel model	Channel with AWGN
Coding rate	1/2

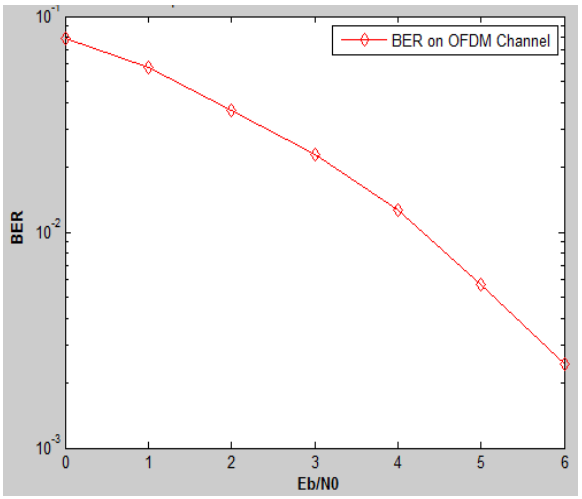

Fig.2 BER Performance for SLM Technique.

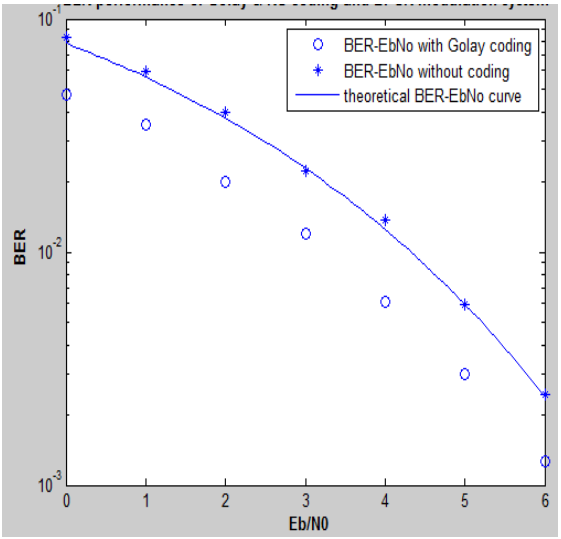

Fig .3 BER Performance for Golay coding technique and un-coding.

Fig.2 and Fig.3 shows the BER Performance of OFDM system using SLM technique and Golay coding technique. this Fig.3 shows the superiority of the proposed system against SLM technique in terms of BER.

ISSN:2319-6890)(online),2347-5013(print)
22 March 2014

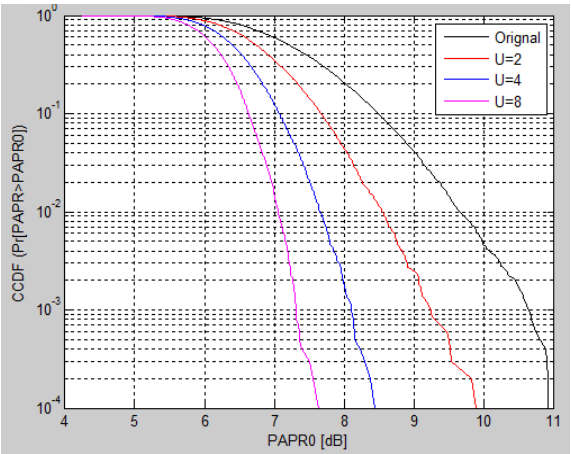

Fig. 4 CCDF Performance of SLM Technique for Different lengths of data.

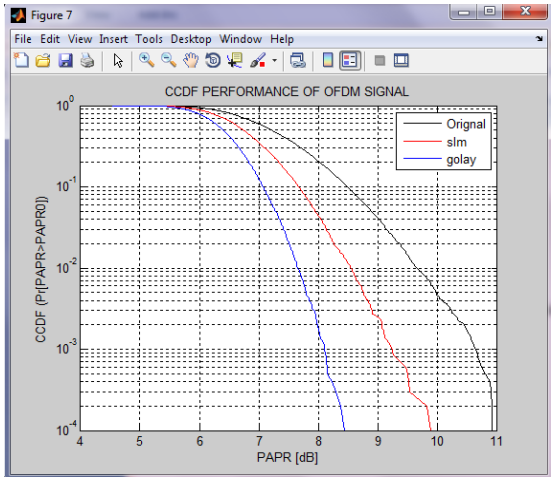

Fig. 5 CCDF Performance of Golay Sequence.

Fig.4 and Fig.5 shows the CCDF Performance of the SLM technique and Golay coding technique. The Fig.5 shows better performance than with the SLM Technique. We clearly notice that the PAPR for a CCDF = 10^{-3}, the PAPR = 10.6db for SLM technique. But for golay coding technique the PAPR = 8db.

4. Conclusion:

This paper proposes a new PAPR reduction technique, that uses golay sequences. The main design criterion of this method is to exploit the efficiency of the golay coder in reducing PAPR of OFDM system, maintain low complexity and without any additional BER loss. The system we designed shows good performance and stands useful for multi path fading channels.

References:

i. *Rafael c. Gonzalez, Richard E. Woods Digital image processing, - Addison-wesley.an imprint of Pearson education, 1st edition.*

ii. *Cherif Rezgui, Slaheddine Jarboui And Khaled Grayaa, "A PAPR Reduction Technique Based on Golay Sequences And Fractional Fourier Transform for OFDM Systems," IEEE Transactions in 2012.*

iii. *Seungsoo Yoo, Seokho Yoon and Sun Yong Kim, and lickho Song, "A Novel PAPR Reduction Scheme for OFDM Systems: Selective Mapping of Partial Tones (SMOPT)," IEEE Transactions on Consumer Electronics, Vol. 52, No. 1, Feb 2006.*

iv. *J.A. Davis and J. Jedwab, "Peak to Mean Power Control in OFDM, Golay Complementary Sequences, and Reed Muller Codes," IEEE Transaction on information theory, VOL. 45, NO. 7, November 1999.*

v. *R. O'Neill and L. B. Lopes, "Envelope Variations and Spectral Splatter in Clipped Multicarrier Signals," Proc. IEEE PIMRC '95, Toronto, Canada, Sept. 1995.*