Volume : 2 | Issue : 5 | May 2013 • ISSN No 2277 - 8179

Research Paper

Engineering

KEYWORDS : PAPR, CCDF, MC-CDMA

A Study of Different Papr Reduction Techniques For MC-CDMA System

Jaswinder Kaur	Department of ECE, Lovely Professional University, Punjab, India
Komal Arora	Department of ECE, Lovely Professional University, Punjab, India
Sunil Kumar	Department of ECE, Lovely Professional University, Punjab, India

ABSTRACT

Wireless communication plays an important role in our daily life. Multicarrier Code Division Multiple Access (MC-CDMA) is an attractive multiple access technique for future wireless communication system due to its high data transmission rate. However, MC-CDMA signals are characterized by large peak-to average power ratio (PAPR), which can reduce the system efficiency. In this paper, we describe various techniques to lower the PAPR for MC-CDMA system.

I. INTRODUCTION

Multicarrier Code Division Multiple Access (MC-CDMA) is a fusion of Orthogonal Frequency Division Multiplexing (OFDM) and Code Division Multiple Access (CDMA) techniques. MC-CDMA is a multiple access scheme which allowing the system to support multiple users at the same time. In MC-CDMA, data symbols consisting of modulated bits are spread by spreading codes and then mapped into subcarriers of a MC-CDMA modem data symbols which is spread across frequency domain [1]. It is an attractive technique for high bit rate and high speed data transmission in mobile communications.

MC-CDMA and OFDM systems are used in the 3rd and 4th generation of wireless networks. However, a major drawback is high peak-to-Average Power Ratio (PAPR) [9]. Due to high PAPR, nonlinear distortion at high power amplifier (HPA) and degradation of the bit error rate (BER). To handle these occasional peaks, a high-power amplifier with linear characteristics over a dynamic range is required. Due to this increased complexity of the ADC and DAC converters and reduced the efficiency of the power amplifiers because the power consumption of a high power amplifier depends on its peak power output rather than the average power output. On the other hand, if a high power amplifier does not handle high peaks, the resulting signal clipping will cause out-of-band radiations and degrade the performance. Different techniques have proposed in literature, according to advantages and disadvantages to lower PAPR. [1] [2]

II. SYSTEM DISCRIPTION

MC-CDMA system has transmitter, to transmit the data and receiver, to receive the data. The Figure 1 shows the block diagram of MC-CDMA transmitter.

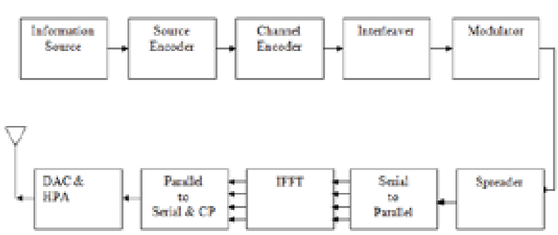

Figure 1: Block diagram of MC-CDMA transmitter

A transmitter is a circuit that accepts signals or data in and translates them into a form that can be sent across a medium, usually over a distance. The medium can be wireless or wired. MC-CDMA system is combination of CDMA and OFDM transmitter. Firstly, the source of informatio n can be analog or digital type. The process of converting output of either analog or digital source into a sequence of binary digits is known as source encoding. After that channel encoder is used to introduced, some redundancy in binary information sequence that can be used at the receiver to overcome the effects of noise and interference encountered in the transmission on the signal through the channel. At the modulation the binary sequence is passed to modulators which is turns converts their sequence into electric signals so that we can transmit them on channel. The spreader spread the data symbols. After it, IFFT block is used to convert this signal to the time domain, before applying the IFFT section of OFDM transmitter. The data is converted back into serial form before cyclic prefix or guard interval is inserted to improve the effect of ISI on an OFDM signal [3]. After the parallel to serial conversion, the data stream send to digital to analog converter followed by high power amplifier and up convertor for transmission. The communication channel is the physical medium that is used for transmitting signals from transmitter to receiver.

The Figure 2 shows the MC-CDMA receiver. The receiver receives the signal which is transmitted by transmitter.

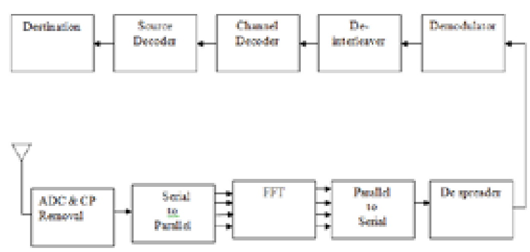

Figure 1: Block diagram of MC-CDMA receiver

The receiver has opposite function of transmitter. Firstly received signal is down converted, and the cyclic prefix or guard interval is removed. After that data is fed to serial to parallel converter and followed by FFT block to convert into frequency domain. Then the signal is followed by despreader, demodulator, de-interleaver, channel encoder, source encoder blocks.

A. Peak- To-Power Ratio (PAPR)

PAPR of MC-CDMA signal p(t) is defined as the ratio between maximum power and its average power during the MC-CDMA signal [4]. The PAPR is calculated by equation (1) as:

$$PAPR = \frac{\max[|p(t)^2|]}{E[|p(t)^2|]} \qquad (1)$$

Where E [.] denotes expected value.

B. Cumulative Distribution Function

The cumulative distribution function (CDF) parameter is used to measure the efficiency on any PAPR technique. Normally CCDF is used instead of CDF. The CCDF of the PAPR defined as the probability that the PAPR of a data block exceeds a given threshold [5]. Let consider, MC-CDMA signal has n data symbols transmitted over NC subcarriers. The CCDF of a PAPR of a data block with Nyquist rate sampling is given as

Volume : 2 | Issue : 5 | May 2013 • ISSN No 2277 - 8179

$$P(PAPR > Z) = 1 - P(PAPR <= Z) \quad (2)$$

$$= 1 - F(z)N_C \quad (3)$$

$$= 1 - (1 - \exp(-Z))N_c \quad (4)$$

This expression is not accurate for a small number of subcarrier.

III. DIIFERENT PAPR RECDUCTION TECHNIQUES

The number of techniques have invented in the literature to lower PAPR [1] [2]. In this paper some basic techniques discussed as:

A. Clipping and Filtering

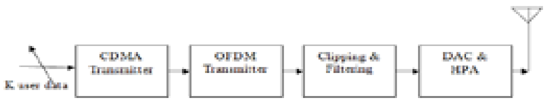

Figure 3: MC-CDMA transmitters with Clipping

The Figure 3 shows the MC-CDMA with clipping. In the clipping and filtering technique, the transmitted signal is send to clipping block which is followed by filtering. After the clipping and filtering block the signal is send to DAC and HPA. Clipping is a process of remove the part of waveform which is maximum and minimum than predetermined value. Clipping simply remove the high amplitude peaks by select the optimum clipping ratio [6]. On the other hand, the performance of the system degrades due to introducing the IBR and OBR. This is improved by the filtering process. With the help of filtering, improves IBR without degradation of BER. In the transmitter clipping and filtering blocks are added but the receiver remains unchanged. This technique is simple as compared with companding, and PTS, SLM, not required side information and no loss in data rate. But distortion and increase BER. [2]

B. Companding

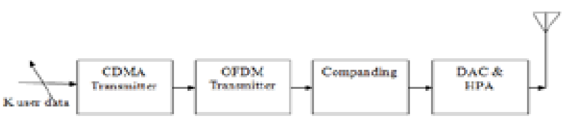

Figure 4: MC-CDMA transmitters with Companding

The Figure 4 shows the MC-CDMA with companding. Companding is a technique for compressing and then expanding an analog or digital signal. The compressing is done at the transmitter side and expanding is done at the receiver side. It attenuates the high peaks and amplifies low amplitude of the MC-CDMA signal. The companding block is added after IFFT block to lower PAPR. There are different types of companding techniques. The μ-law companding technique, increasing the average power of the transmitted signals because it amplifies only small signals and cause side lobe generation. Exponential companding schemes amplify small and large amplitude signals, while maintain constant average power and causes less spectrum side lobes [2]. Exponential companding technique is better than μ-law companding technique to lower PAPR in the MC-CDMA system. This technique has advantages like better power spectral density, low implementation on complexity, no constraint in modulation format and sub carrier size but out band radiation [7] [8].

C. The Partial Transmit Sequence

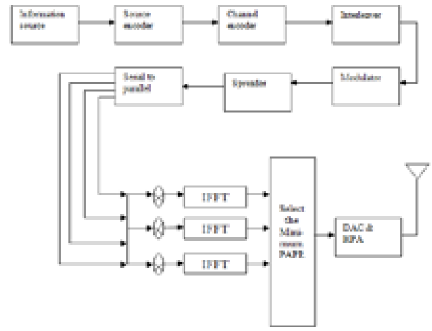

Figure 5: MC-CDMA system using PTS

The Figure 5 shows MC-CDMA with PTS technique. In this technique the input data frame is divided into non-overlapping sub-blocks and each sub-block is phase shifted by constant factor. After it the block with minimum PAPR is select for transmission. Many modified techniques are proposed with less complexity. There are three different kinds of sub- block partitioning schemes on which the performance of PTS technique depends: adjacent, interleaved, and pseudorandom [1]. PTS technique less complex and reduce better PAPR than SLM. However, it required large side information than SLM. [8] [9]

D. The Selective Mapping

The Figure 6 shows the MC-CDMA with SLM technique. SLM scheme is based on phase rotation to generate number of candidate signals.

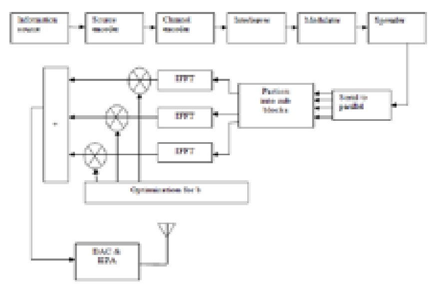

Figure 6: MC-CDMA system using SLM

In this technique, [1]-[2] signal is divided in sub-blocks. These different blocks have same information and each data block is multiplied with different phase sequences having each of length say N. The result having one un-modified data block and modified data blocks. The one with lowest PAPR is selected for transmission. The amount of PAPR reduction depends on design of phase sequences [1]. For this technique, side information is needed and complexity increases with increase in number of phase factors. But no distortion is introduced and more effective than PTS for same amount of side information [11].

E. Hybrid Technique

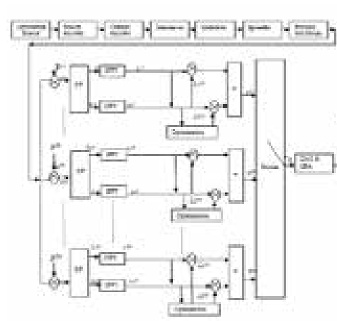

Figure 7: MC-CDMA system using Hybrid

The Figure 7 shows the MC-CDMA with hybrid technique. It is the combination of SLM-PTS technique. In this technique, first PTS technique after it, SLM technique is applied. First of all, the original signal is multiplied with the *U* phase rotation sequences, and then new data signal is divided into no. of sub-blocks. After it, PTS technique is applied and sub-blocks values find by optimization block. The side information is necessary to receive the signal at receiver side. Hybrid technique reduces PAPR better as increase the no. of phase rotation sequence but has drawback of high computational complexity [12].

F. Precoding Transform Techniques

The Figure 8 shows the MC-CDMA with precoding transform technique

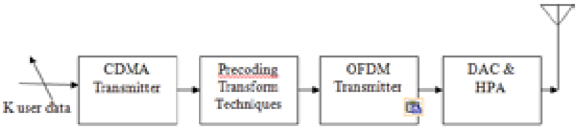

Figure 8: MC-CDMA system using Precoding Transform Technique

In this technique, the CDMA signal is send to precoding transform block. After applied different transform techniques, the signal is followed by IFFT block of OFDM signal to reduced PAPR of the MC-CDMA system. Different precoding transform technique like Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) Discrete Hartley Transform (DHT) used [1] [13]. The DCT does not influence BER but increase complexity. DHT shows better reduction in PAPR, when it compared with SLM technique and increased complexity. The DWT has more advantages like high spectral efficiency, no distortion and data loss than DCT, DHT techniques. However DWT is also suffered from complexity. [2] [4]

IV. CONCLUSION

MC-CDMA gained a lot attention for future generation of wireless communication systems. But MC-CDMA signal has drawback of high PAPR. In this paper, different techniques discussed to lower the PAPR in MC-CDMA systems. With the reduction of PAPR, MC-CDMA has applications in the area of wireless communications such as Broadband Multi-User Communications, WLANs and Broadcasting.

REFERENCE

[1] B. Sarala, D.S.Venkateswarulu B.N.Bhandari “Overview of MC-CDMA PAPR Reduction Techniques”, IJDPS vol.3, no.2,pp. 193-206, March 2012 | [2] Gagandeep Kaur, Rajbir Kaur “An Overview of PAPR Reduction Techniques for an MC-CDMA System”, IJERA, issue 4, vol. 1, pp.461-470, June 2012. | [3] Khaled Fazel, S. Kaiser, “Multi-Carrier Spread-Spectrum: For Future Generations Wireless Systems”, Springer, 2003. | [4] B. Sarala, D.S. Venkateswarlu, “MC-CDMA PAPR reduction techniques using Discrete Transforms and Companding”, IJDPS vol.2, no.6, pp. 253-270, November 2011. | [5] Wang Yi Gu linfeng “An Investigation of Peak-to-average Power Reduction in MIMO OFDM Systems”, Blekinge Institute of Technology, October 2009. | [6] X. Li And L. J. Cimini Jr., “Effects of Clipping and Filtering on the Performance of OFDM”, IEEE Commn. Lett. vol. 2, no.5, pp. 131-133, May 1988. | [7] J. Kim, S. Han, and Y. shin, “A Robust companding scheme against Non-linear distortion of high power amplifiers in OFDM systems”, IEEE Trans. Vehicular Technology Conference, pp.1697-1701, May 2008. | [8] Jun Hou, Jianhua Ge, and Jing Li “Peak to average Power ratio Reduction of OFDM Signals using PTS scheme with Low computational complexity”, IEEE trans. on broadcasting, vol.5, no.1, pp .143-148, March 2011. | [9] Gagandeep Kaur, Rajbir Kaur “ PAPR Reduction of an MC-CDMA System through PTS Technique using Suboptimal Combination Algorithm”, IJERA,issue 4, vol. 2, pp.1192-1196, July 2012. | [10] Gagandeep Kaur, Rajbir Kaur “Comparative study of SLM and PTS techniques for PAPR Reduction of an MC-CDMA system”, IJERA vol. 2, pp.779-784, July 2012. | [11] Gagandeep Kaur, Rajbir Kaur “PAPR Reduction of an MC-CDMA system using SLM technique”, IJERA, issue 4, vol. 1, pp.456-460,June 2012. | [12] Hong-Jie Chou, Hong-Jie Chou “PAPR Reduction Techniques with Hybrid SLM-PTS Schemes for OFDM Systems” IEEE, pp. 1-5, May 2012. | [13] S.Prabha, .Meenakshi, N.R.Raajan “Impression of PAPR Reduction Techniques in MC-CDMA”, ICCCMIT pp.29-32 2012. |