Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 8 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

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GJRE-F Classification : FOR Code: 090609, 090699

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I. Introduction

Orthogonal frequency division multiplexing (OFDM) is becoming the chosen modulation technique for wireless communications. Orthogonal Frequency Division Multiplexing (OFDM) can be termed as an alternative wireless modulation technology to CDMA. OFDM (Orthogonal Frequency Division Multiplexing) is a multicarrier modulation that is implemented in many recent wireless applications due to its ability to combat impulsive noise and multipath effects and make better use of the system available bandwidth. It has been adopted for the European Digital Audio Broadcasting (DAB) [1] and Digital Video Terrestrial Broadcasting (DVB) standards, it has been proposed for UMTS (Universal Mobile Telecommunication Systems) [2] and it has just been standardized for new wireless LAN generations (HIPERLAN: High Performance Radio LAN. OFDM offer high spectral efficiency, immune to the multipath delay, low inter- symbol interference (ISI), immunity to frequency selective fading and high power efficiency. Due to these merits OFDM is chosen as high data rate communication systems such as Digital Video Broadcasting (DVB) and based mobile worldwide interoperability for microwave access (mobile Wi-MAX)[3]. The basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers. These subcarriers are overlapped with each other. Because the symbol duration increases for lower rate parallel subcarriers, the relative amount of dispersion in time caused by multipath delay spread is decreased. Inter-symbol interference (ISI) is eliminated almost completely by introducing a guard time in every OFDM symbol [4]. The entire data stream of OFDM is divided into different blocks of N symbols each. Each block is multiplied with U different phase factors to generate U modified blocks before giving to IFFT block. Each modified block is given to different IFFT block to generate OFDM symbols. PAPR is calculated for each modified block and select the block which is having minimum PAPR ratio.

In this paper we have investigate OFDM signals, Clipping and Filtering method, OFDM signals with and without Clipping and Filtering method and compare between them.

II. OFDM System Model

OFDM is a special form of multicarrier modulation (MCM) with densely spaced subcarriers with overlapping spectra, thus allowing multiple-access [5]. MCM works on the principle of transmitting data by dividing the stream into several bit streams, each of which has a much lower bit rate and by using these sub-streams to modulate several carriers. In multicarrier transmission, bandwidth divided in many non-overlapping subcarriers but not necessary that all subcarriers are orthogonal to each other [5]. In OFDM the sub-channels overlap each other which leads to an efficient use of the total bandwidth. The information and sent over the N sub-channels, one symbol per channel. To permit dense packing and still ensure that a

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minimum of interference between the sub-channels is encountered, the carrier frequencies must be chosen carefully. By using orthogonal carriers, frequency domain can be viewed so as the frequency space between two sub-carriers is given by the distance to the first spectral null [6].

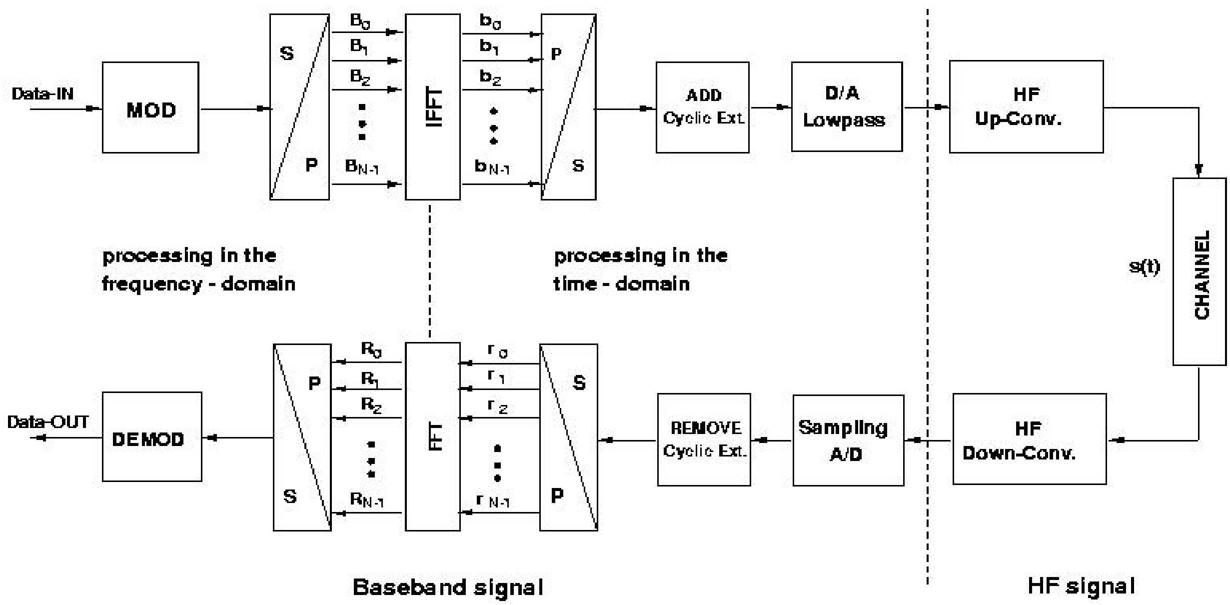

Fig 1 : OFDM system model

By converting a single high frequency carrier to several sub-carriers, OFDM enhances the ability to cope with frequency selective fading effects and narrow bandwidth interference. The orthogonal property also greatly simplifies the design of both transmitter and receiver. A receiver can detect every sub-carrier data, which commonly is done via Fast Fourier Transform (FFT). Therefore a separate filter for each sub channel is not required. However, in practice, the sub-carriers are modulated in different amplitude and phase [7].

a) Peak to Average Power Ratio(PAPR) for OFDM signal

The peak to average power ratio for a signal x(t) is defined as

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

Where $()^*$ corresponds to the conjugate operator [8]. Expressing in deciBels,

$$PAPR_{dB} = 10\log_{10}(PAPR) \quad (2)$$

b) PAPR of a complex sinusoidal signal

Consider a sinusoidal signal $x(t) = e^{2\pi ft}$ having the period T. The peak value of the signal is

$$\max[x(t)x*(t)] = +1 \quad (4)$$

The mean square value of the signal is

$$E[x(t)x*(t)] = \frac{1}{T}\int_0^T \exp^{4\pi ft} = 1 \quad (5)$$

Given so, the PAPR of a single complex sinusoidal tone is, PAPR=1[8].

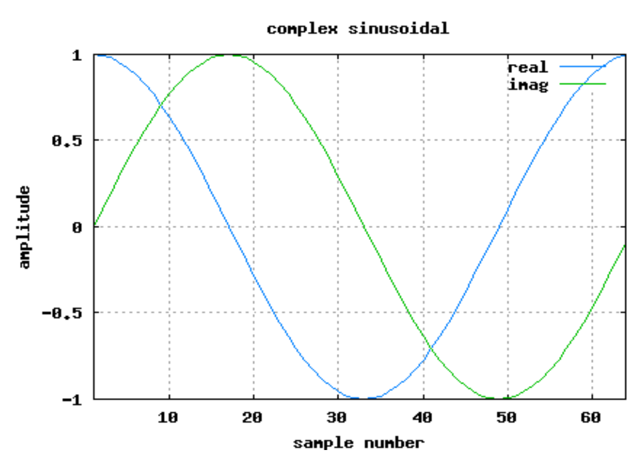

Fig 2 : PAPR of a complex sinusoidal

c) Clipping and Filtering Technique

In OFDM, signal contains high peaks (exceeding a certain threshold) will be applied to clipping and Filtering processes (CAF) as illustrated in fig.-3. In the Clipping part, when amplitude exceeds a certain threshold, the amplitude is hard-clipped while the phase is saved [9-10].

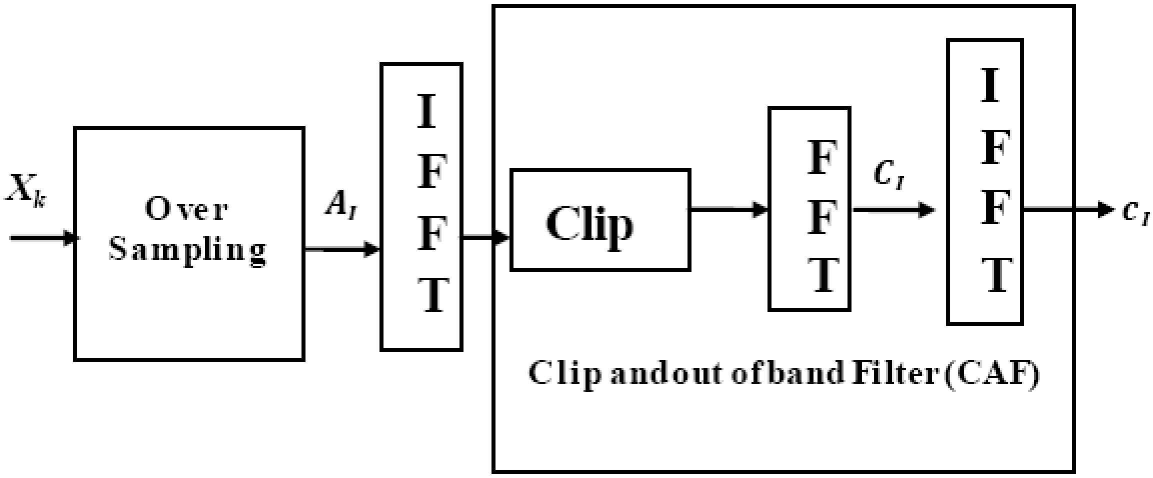

Fig 3 : Repeating clipping and filtering technique

In fig-3, vector $A_1 = [A_0........A_{N-i}]$, obtained after oversampling stage is first transformed using an oversize inverse fast Fourier transformation (IFFT). For an oversampling factor denoted by IF, A_1 is extended by adding N(IF-I) zeros in the middle of the vector. This results in a trigonometric interpolation of the signal time domain signal [I]. The interpolated signal is then clipped. In this paper, hard-limiting is applied to the amplitude of the complex values at the IFFT output. However, any other form of nonlinearity could be used. The clipping ratio, CR, is defined as the ratio of the clipping level value to the root mean square value of the unclipped signal. The clipping is followed by filtering to reduce out-of band power. The filter consists of two FFT operations. The forward FFT transforms the clipped signal back into the discrete frequency domain resulting in vector. The in- band discrete frequency components of, $[C_{0,i},....,C_{N/2-1,i,}C_{NI1-N/2,i,}...C_{NI1-1,i}]$, are passed unchanged to the inputs of the second IFFT while the out-of-band components ,$[C_{N/2+1,i,}.... C_{NI1-N/2,i}]$ are nulled. In systems where some band-edge subcarriers are unused the components corresponding to these are also nulled. The resulting filter is a time-dependent filter, which passes in-band and rejects out-of-band discrete-frequency components. This means that it causes no distortion to the in-band OFDM signal. Since the filter operates on a symbol-by-symbol basis, it causes no Inter-symbol interference. The filtering does cause some peak to re-growth. Clipping method sets a clipping threshold, when the amplitude of the signals over the threshold, then cut the high peak power. According to the system acquirement, the following function has been used to calculate the clipping ratio. PAPR0=10logCR, where, PAPR0 is the threshold value, and CR is the clipping ratio. Due to the relation between PAPR0 and the system BER, PAPR0 is selected to be inverse ratio to BER. In this case, proper threshold value should be selected carefully.

III. Simulation and Results

The Cumulative Distribution Function (CDF) is one of the most regularly used parameters, which is used to measure the efficiency of any PAPR technique. Normally, the Complementary CDF (CCDF) is used instead of CDF, which helps us to measure the probability that the PAPR of a certain data block exceeds the given threshold. The CCDF of the PAPR of the data block is desired in our case to compare outputs of various reduction techniques [7-8].

The simulation result of amplitude clipping method is shown in Fig-4. It can be observe that OFDM signal is has higher PAPR and after applying this method PAPR is reduced significantly. This PAPR is decreases as the number of clip and filtering is increased from one to two levels. Because the clipping is followed by filtering to reduce out of band power.

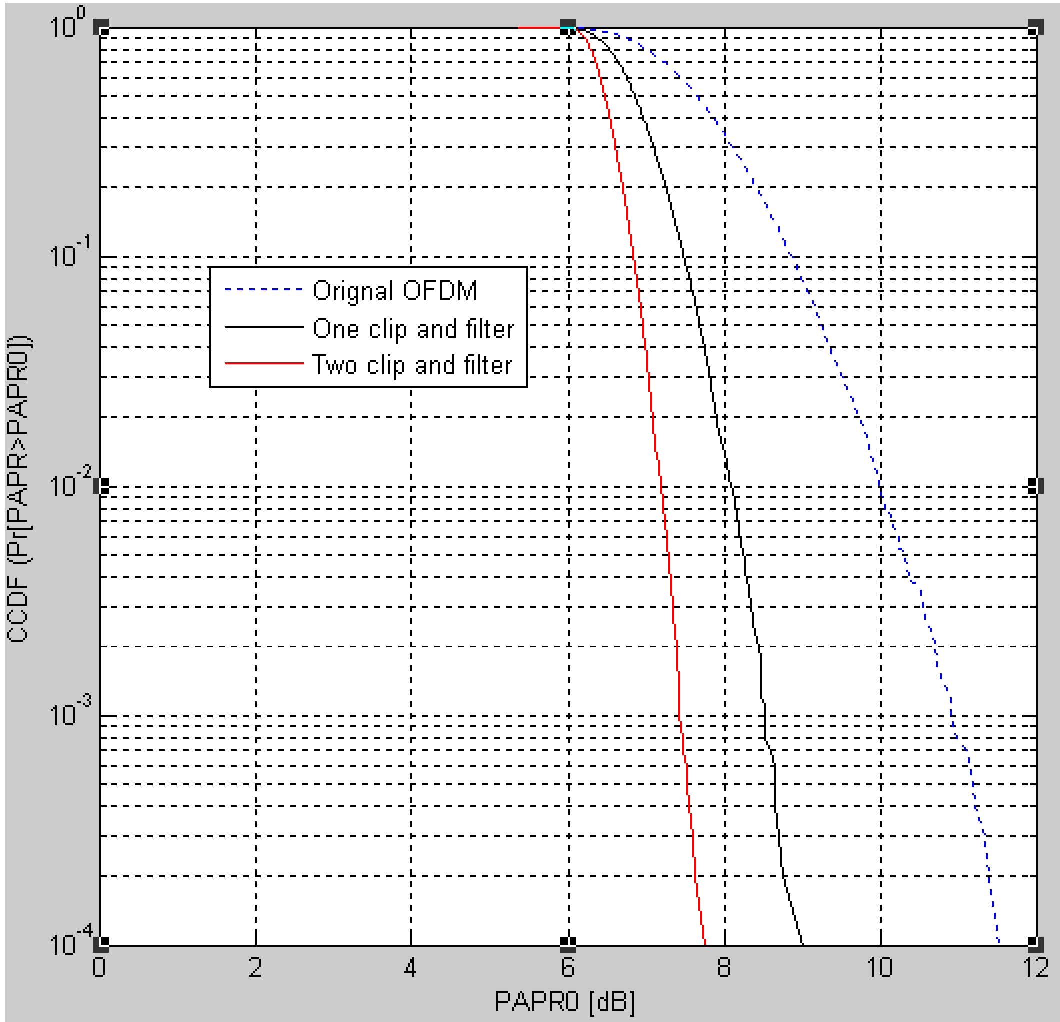

Fig 4 : Comparison of CCDF using one/two clipping and filtering method

IV. Conclution

In conclusion, OFDM technology summed up a number of sub carriers modulated by group of data symbol. Therefore, transmitted signal may have a relatively large peak power which leads to high PAPR. The principal drawback of OFDM is that the peak transmitted power can be substantially larger than the average power. We observe that the PAR-reduction problem for OFDM has received a great deal of attention recently. In this paper, It can be observe that OFDM signal is has higher PAPR and after applying this method PAPR is reduced significantly. This PAPR is decreases as the number of clip and filtering is increased from one to two levels. Because the clipping is followed by filtering to reduce out of band power. The DFT transform the clipped signal into frequency domain signal.

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