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Research Article

Evaluate the PAPR and BER Performance of SCFDMA with NCT Technique

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Abstract

Orthogonal frequency division multiplexing (OFDM) is a most efficient and well-known modulation technique for transmission of digital data with high data rate. It is a multicarrier modulation technique where a high data rate signal is divided in to the number of lower data rate signal and these lower data rate signal are placed on the different sub bands where each lower data rate signal is modulated through an individual sub carriers so by combining all modulated signal we get the OFDM transmitted signal. It is most effective technique for overcome the problem of multipath fading, immunity to delay spread Increasing signal to noise ratio (SNR) with negligible Inter carrier interference (ICI) and Inter symbol interference (ISI).High peak to average power ratio(PAPR) is main problem with OFDM that degrade the performance of system. There are various techniques has been demonstrated to reduce PAPR like signal scrambling or signal distortion technique and also improving the bit error rate of the system. In this paper, we have evaluated the PAPR and BER performance of single carrier frequency division multiplexing (SC-FDMA) with nonlinear companding technique.

Keywords: *Orthogonal frequency division multiplexing, Peak to average power ratio, SCFDMA, NCT.*

1. Introduction

There are lots of technologies developed in the field of both wired and wireless communication but nowadays, demand of high speed communication system is increasing day by day. Due to the increased demand in the mobile applications next generation wireless mobile system is designed in such way that they supports voice calls but also high performance data applications over radio wave communication system. A new technique orthogonal frequency division multiplexing has been introduced which fulfills this need and widely accepted by fourth generation. OFDM is a most efficient and well-known modulation technique for transmission of digital data with high data rate with up to 20 mbps data rate and 3Mbps for moving vehicle at low latency and good spectral efficiency (Nee, *el al 2000*).It is a multicarrier modulation technique (Ruggieri, *el al 2003*) where a high data rate signal is divided in to the number of lower data rate signal and these lower data rate signal are placed on the different sub bands where each lower data rate signal is modulated through an individual sub carriers so by combining all modulated signal we get the OFDM transmitted signal. OFDM modulation technique overcome the drawback of multipath fading and provides resistance against frequency selective fading channel, immunity to delay spread, low implementation complexity, uniform average power spectral density, very much capable to handle strong echoes and less occurrence of non-linear distortion Increasing signal without degrading BER of the signal In OFDM system, to avoid inter carrier interference number of carrier in the system are orthogonally modulated with each other and all of them follow orthogonal principle. orthogonality means that each carrier has an integer number of cycles over a symbol period. It ensures that center frequency of each carrier is located on the other subcarriers zero crossing points in the system.

OFDM system has a lot of uses in the field of wireless and wired communication. It has been used in DAB, Digital television DVB-T (terrestrial), DVBH (handheld), digital television and high-definition television (Couasnon, *el al 1994*). (HDTV, high-bit-rate digital subscriber lines (HDSL), and also in wireless LAN and MAN applications, including IEEE 802.11a/g/n, WiMAX and Mobile phone 4G.

A major drawback with OFDMA system is high PAPR and sensitive to frequency offset and phase noise. The problem of PAPR comes from the nature of modulation of OFDM where number of sinusoidal subcarrier may get added up the same time constructively that causes such a high power to transmit it, compared to overall average power of the OFDM system.

The PAPR of the signal is given as the ratio between the peak instantaneous power and the average power occur in OFDM symbol transmission

$$\text{PAPR} = \frac{\text{Peak power}}{\text{Average power}}$$

$$PAPR = \max_{0 \le t \le T} \frac{|x(t)|^2}{E[|x((t)|^2]}$$

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Where E [.] denotes the expectation operator.

PAPR= Number of sub-carrier (N)

PAPR in terms of decibel may be calculated as follows:

PAPR = 10 log (N)

Hence, PAPR increases with increasing number of sub-carrier.

In OFDMA system the information symbol are loaded on to the sub-carrier and passes through the IFFT block which convert frequency domain information symbol into the time domain. Hence, signal generation in OFDM system based on IFFT operation on transmitter side and each sub-carrier only carries information related to one specific symbol.

Transmitter side

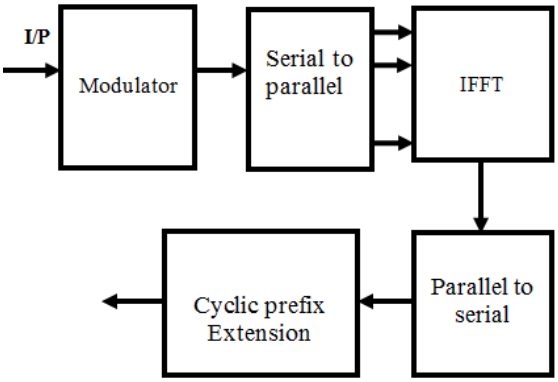
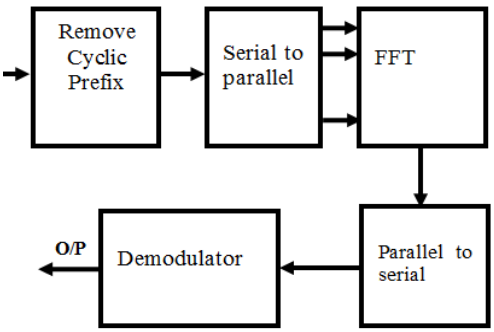


Fig.1 Transmitter structure of OFDMA

Receiver Side



PAPR in OFDMA system occur due to the IFFT operation because Information symbol are randomly loaded onto the number of sub-carrier and add up receiver to produce high peak value signal. While PAPR depends on number of sub carrier i.e. PAPR increases with increasing number of sub carrier. High PAPR reduces the performance of the system**,** increases complexity and reduces efficiency of the RF power amplifier.

To reduce the problem of PAPR in OFDM system the technique of SCFDMA is employed (Myung *et al 2006*).In SCFDMA each sub-carrier contains information of all transmitted symbol. It is an improved version of OFDMA system which has two new block FFT and carrier mapping but for further reduction of PAPR we also employed the technique of NCT over SCFDMA (Wang, *et al 2012*, Jiang *et al 2004)*.It has an improved version of OFDMA system with similar structure, throughput performance and complexity which has low PAPR and high power efficiency. It is single carrier modulation technique and suitable for uplink multiple access transmission of 3GPP LTE (Ekström, *et al 2006*).

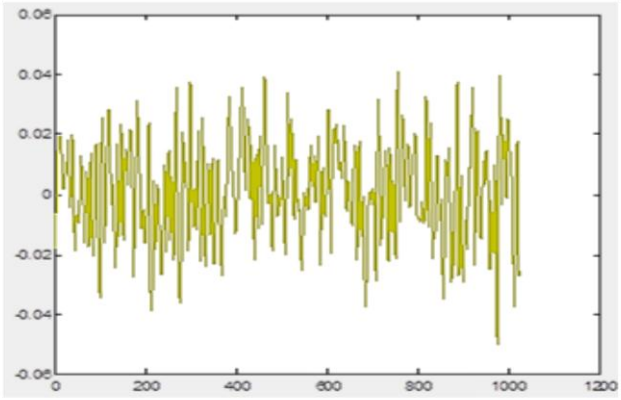


Fig.3 OFDM signal containing sinusoidal high peaks

2. Simulation Setup

TO Evaluate the PAPR and BER performance of SCFDMA using NCT technique, MATLAB simulator tool is used

Table 1 Simulation Parameters

Parameters	**Value**
sub-carrier(N)	512
Bandwidth spreading factor	32
Transmission bandwidth	5 MHz
Input data block size	16
Modulation technique	QAM
Pulse shape	Raised-cosine (RC) and square Raised-cosine(RRC)

Proposed scheme to evaluate the performance

Fig.4. Shows the block diagram SC-FDMA with NCT technique. SCFDMA system has two extra block M-Point FFT and sub-carrier mapping block. FFT Block converts time domain information symbol into the frequency domain symbol. Furthermore, this frequency domain information symbol passes through the sub-carrier mapping and mapped to a subset of subcarriers, then applied to the IFFT. Hence, PAPR can be reduced by using FFT block which converts the system into single carrier system. However, most important thing is M<N while the remaining part of SC-DMA is same as modified OFDM system.

There are two type of carrier mapping used in SCFDMA; Distributed Mapping., Localized Mapping

In interleaved frequency division multiple access (IFDMA) mapping scheme, the FFT outputs of the input

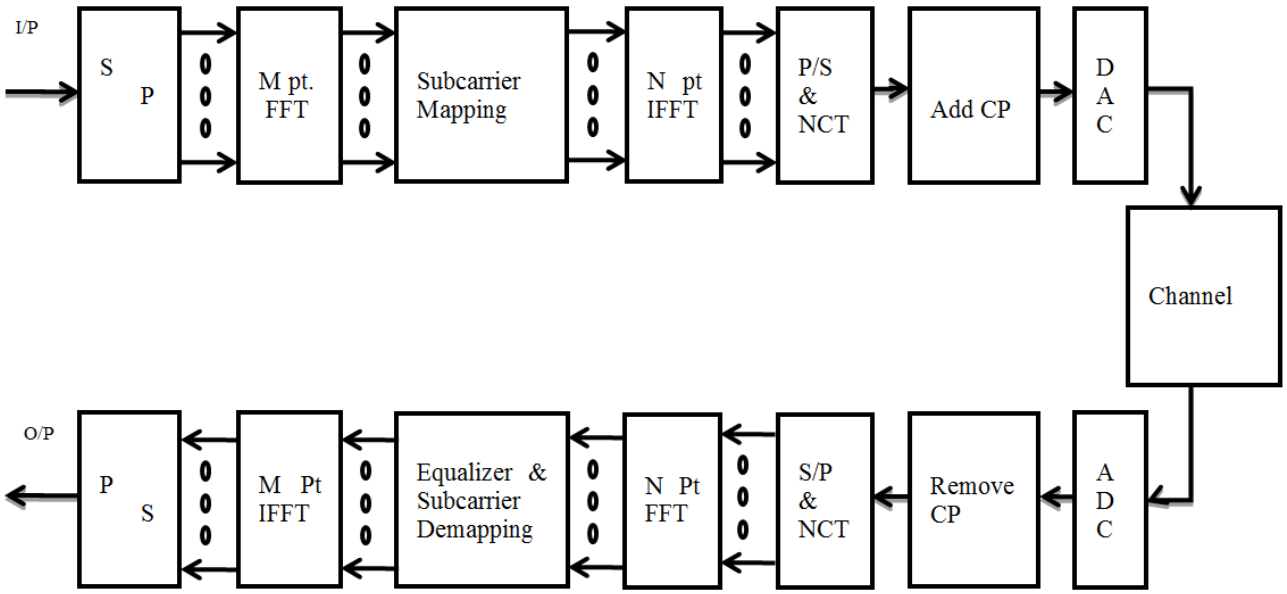


Fig.4 Transceiver structure of SCFDMA with NCT**.**

data are placed on the entire subcarriers with zeros occupying in unused subcarriers (Sorger, *et al 1998).*

X(0)	**0**	**0**	**X(1)**	**0**	**0**	**X(2)**	**0**	**0**

Fig.5. IFDMA based mapping with 9 sub-carrier.

In Located FDMA (LFDMA) based scheme, FFT outputs of the input data are placed on the consecutive subcarriers in the form of chunk

0	**0**	**X(0)**	**X(1)**	**X(2)**	**X(3)**	**0**	**0**

Fig.6. Location based mapping with 8 sub-carrier**.**

Output of the IFFT is applied to compander .In this paper, nonlinear compander is used to reduce PAPR

$$f(x)=\begin{cases}\operatorname{sgn}(x)\left(\dfrac{p+1}{k}\left(1-e^{\left(-\left(\frac{|x|^2}{\sigma^2}\right)\right)}\right)\right)^{\frac{1}{p+1}}, & |x|\le\alpha\\ \operatorname{sgn}(x)\left(\dfrac{1-e^{\left(-\left(\frac{|x|^2}{\sigma^2}\right)\right)}}{k(cA)^p}+\dfrac{pcA}{p+1}\right), & |x|>\alpha\end{cases}$$

The transform parameters such as k and p are variables that help to achieve BER and PAPR reduction result

$$k=\frac{p+1}{c^pA^{p+1}(p+1-pc)}$$

$$A=3\sigma^2\frac{p+3}{p+1}.\frac{p(1-c)+1}{p(1-c^3)+3}$$

$$\alpha=\sigma\left(-\ln\left(1-\frac{k(cA)^{p+1}}{p+1}\right)\right)^{\frac{1}{2}}$$

3. Result and Discussions

The performance of the SCFDMA technique is evaluated in terms of the reduction of the PAPR and BER performance using MATLAB simulations software. PAPR of the system can be characterized by CCDF (Complementary Cumulative Distribution Function). Furthermore compared the performance of OFDMA, SCFDMA and the proposed scheme.

In our simulation model we have taken the total number of subcarriers as 512, input data block size to 16 and bandwidth spreading factor to 32.Transmission bandwidth of 5 MHz and symbol constellations 16-QAM and for pulse shaping purpose raised-cosine (RC) pulse and squared-root raised-cosine (RRC) pulse are used.

In figure 7 CCDF plots of PAPR for the OFDMA, SC/IFDMA using 16QAM modulation with pulse shaping formats respectively. We can easily compare that single carrier frequency division multiple access technique with IFDMA carrier mapping scheme is able to reduce PAPR 2.3 dB better than OFDM system.

Figure 8 Show CCDF plots of PAPR for the OFDMA, SC/IFDMA with pulse shaping and SC/IFDMA with nonlinear companding transfer technique respectively. We can compare that SC/IFDMA with NCT scheme is more reliable to reduce PAPR 1.5 dB better than SC/IFDMA without NCT than OFDM system.

Figure 9 show BER performance of SC/IFDMA and SC/IFDMA with NCT.It can be compare that BER of the SC/IFDMA with NCT is not good than SC/IFDMA but SNR for proposed SC/IFDMA with NCT is 13.3 dB which is roughly 2.7dB higher than SC/IFDMA so overall performance of proposed technique is good than other.

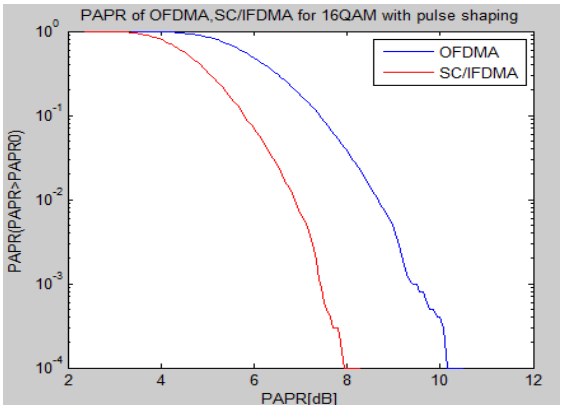


Fig.7 CCDF plots of PAPR for the OFDMA, SC/IFDMA

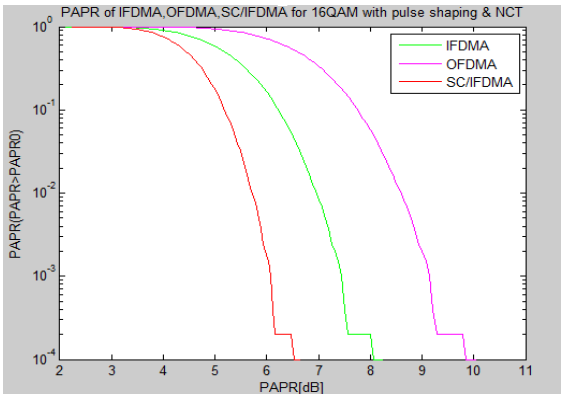


Fig.8 CCDF plots of PAPR for the OFDMA, SC/IFDMA and SC/IFDMA with NCT

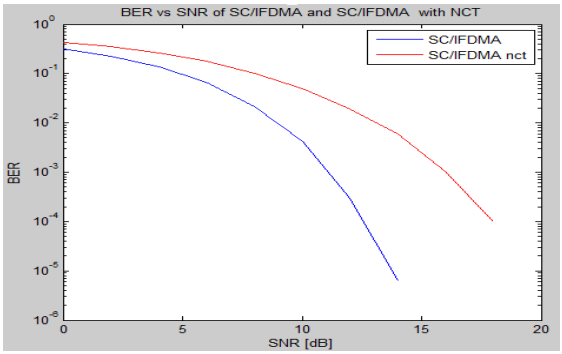


Fig.9 BER plot of SC/IFDMA and SC/IFDMA with NCT

4. Conclusion

After observing the result it is concluded that, PAPR performance of single carrier frequency division multiple access (SCFDMA) technique with NCT is good as compared to SC/IFDMA and OFDMA. While BER performance of proposed scheme is not good than IFDMA. Hence, overall performance of SCFDMA with NCT is effective and reliable than other.

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