ISSN 2347-4289

On The Reduction Of Papr In The Multicarrier Techniques Based On Mobile Wireless System

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ABSTRACT :OFDM is very attractive technique now a day due to its various benefits like easy and efficient in dealing with multipath, robust in nature, spectral efficiency and high speed data transmission. Thus because of its applications OFDM plays a vital role for upcoming 4G wireless communication. OFDM works either as the multiplexing or modulation technique. It has also been used in broadband multimedia wireless services. Beside of its application, one major drawback of OFDM system is high Peak to Average Power ratio (PAPR) which causes non-linearity at the receiving end. The paper describes the PAPR problem in OFDM system and various PAPR reduction techniques that are used to reduce the PAPR have been discussed. The PTS technique for 16 QAM/OFDM systems is used to reduce the PAPR and simulation results are then analyzed. Also, SC-FDMA is another technique which can replace the OFDM. Thus the subcarrier mapping schemes of SC-FDMA has been described. The results for IFDMA and LFDMA for 16QAM modulation technique are shown when DFT spreading technique is applied.

Keywords : OFDM, PAPR, PTS, SC-FDMA, IFDMA, LFDMA

1 INTRODUCTION

The adoption of OFDM for downlink radio transmission by 3GPP for cellular long term evolution (LTE) and SC-FDMA for uplink transmission follows the successful implementation of OFDM for a variety of other applications including digital subscriber loops, wide area broadcasting (digital audio and video), and local area networks. In OFDM technique the user data stream is spitted into several sub-streams then it multiplexes the data on several subcarriers and transmits it in parallel. OFDM uses orthogonal subcarriers, which overlap in the frequency domain [1]. OFDM extends the symbol duration of the individual data and uses orthogonal subcarriers to convey the lower data rate in parallel which mitigate the Intersymbol Interference in OFDM system. Since each subcarrier signal is time-limited for each symbol, an OFDM signal may incur out-of-band radiation, which causes non-negligible adjacent channel interference (ACI). Therefore, OFDM scheme places a guard band at outer subcarriers, called virtual carriers (VCs), around the frequency band to reduce the out-of band radiation. The OFDM scheme also inserts a guard interval in the time domain, called cyclic prefix (CP), which mitigates the inter-symbol interference (ISI) between OFDM symbols. The transmit signals in an OFDM system can have high peak values in the time domain since many subcarrier components are added via an IFFT operation. Therefore, OFDM systems are known to have a high PAPR [2]. The high PAPR is a serious problem in OFDM system as it decreases the SQNR (Signal-to-Quantization Noise Ratio) of ADC (Analog-to-Digital Converter) and DAC (Digital-to-Analog Converter) while degrading the efficiency of the power amplifier in the transmitter.

1.1 Peak to Average Power Ratio (PAPR)

The well-known advantages of OFDM/OFDMA are sometimes counter-balanced by one major problem: The high PAPR as discussed above. The PAPR is defined as maximum instantaneous signal power to that of average signal power.

$$PAPR = P_{peak} / P_{avg}$$

When transmitting data from mobile terminal to the network, a power amplifier is required to boost the signal to higher level. The power amplifier is one of the biggest consumers of energy in a device and should thus be as power efficient as possible to increase the operation time of the device on a battery charge. As the power amplifier should remain in linear region but when OFDM is used for uplink transmission in LTE, heavily consume the battery power of UE (User Equipment) because OFDM transmit multiple signals at one time which transfer the power amplifier in non-linear region and cause Inter symbol interference. High PAPR means power back off is required to remain in the linear region of the amplifier [3].

2. PAPR REDUCTION TECHNIQUES

Thus PAPR degrades the transmit power efficiency performance. Hence different techniques are required to reduce the PAPR problem in OFDM. PAPR reduction techniques vary according to the requirement of the system and are dependent on various factors such as PAPR Spectral efficiency, increase in transmit signal power, loss in data rate, complexity of computation and increase in the bit-error rate (BER) at the receiver end. The most useful techniques that are used to reduce the PAPR are given below:

- Block Coding Technique
- Selective Level Mapping (SLM)
- Clipping Technique
- Partial Transmit Sequences (PTS)
- Single Carrier Frequency Division Multiple Access Technique (SC-FDMA)

2.1 Block Coding Technique

In this technique different set of code words and block codes are used to reduce tha PAPR in OFDM signal. Coding technique is the non-distortion PAPR reduction technique which means it will not distort the OFDM signal. This is the simplest method but it could not work for the higher order bit rates. Sub block coding technique is the part of this technique which is used when PAPR exceeds the value of 3 dB. PAPR reduction can be achieved largely by using this method but it will result in the noticeable loss of data rate [4].

2.2 Selective Level Mapping (SLM) Technique

In this method the parallel input data vector is multiplied with different phase sequences (each of length N) to create modified data blocks with different phases before the IFFT operation. Then after the IFFT operation, among the modified data blocks the block having minimum PAPR is selected for transmission. Information about the selected phase sequence should be transmitted to the receiver as side information and this is the reason for complexity. SLM can be used for any number of subcarriers and for any signal constellation. It provides significant gain with moderate complexity [5].

2.3 Clipping Technique

The clipping technique employs clipping or nonlinear saturation around the peaks to reduce the PAPR. This is simple technique but spoils the orthogonality of OFDM subcarriers. Simple clipping technique, joint clipping and filtering technique, peak windowing technique, peak cancellation technique and nonlinear companding transform etc are the types of clipping technique. It may affect high-frequency components of in-band signal (aliasing) when the clipping is performed with the nyquist sampling rate in the discrete-time domain [6].

2.4 Partial Transmit Sequence (PTS)

Partial Transmit Sequence (PTS) algorithm is a technique for improving the statistics of a multicarrier signal. The idea behind partial transmit sequence algorithm is to divide the original OFDM sequence into several sub-sequences and each sub-sequences multiplied by different weights until an optimum value is chosen [7].

2.5 Single Carrier Frequency Division Multiple Access Technique (SC-FDMA)

Another method is to replace the OFDM with SC-FDMA during uplink transmission. SC-FDMA is a simple technique for high data rate uplink communication and has been adopted by 3GPP for it next generation cellular system, called LTE. SC-FDMA is a modified form of OFDM with similar throughput performance and complexity. There is considerable interest in the use of SC-FDMA as the uplink transmission scheme in the 3GPP-LTE standard. This interest is justified by the inherent single carrier structure of SC-FDMA, having lower phase noise and PAPR as compared to OFDM [8].

3 SYSTEM METHODOLOGY

The section deals with the system methodology of PAPR reduction of OFDM system through PTS sub-block partition scheme and SC-FDMA technique, when DFT spreading technique is applied on IFDMA and LFDMA subcarrier mapping schemes of SC-FDMA.

3.1 Reduction of PAPR using PTS

Partial Transmit Sequence (PTS) algorithm is described in this paper to reduce the PAPR value of OFDM. This method is similar to SLM, but the main purpose behind this method is that the input data frame is divided into non-overlapping sub blocks and each sub block is phase shifted by a constant factor to reduce PAPR. PTS is probabilistic method for reducing the PAPR problem as there is no need to send any side information to the receiver of the system, when differential modulation is applied in all sub blocks [9].

Flow chart of the PTS technique used for PAPR reduction is given below:

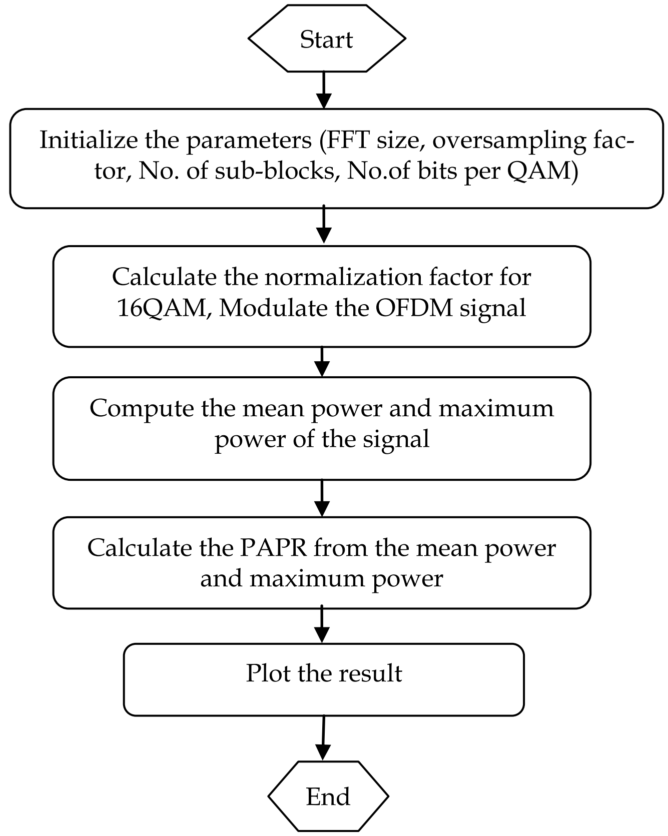

Fig. 1

Table 1 show the parameters of 16 QAM/OFDM signal which is used for PAPR reduction by using PTS technique. Here FFT size and number of sub blocks varies to achieve the required result. The oversampling factor and number of bits per QAM symbols is 4 and number of OFDM blocks for iteration is 3000.

TABLE 1

S.No	Parameter	Value
1	FFT size	128, 64, 32
2	Oversampling factor	4
3	No. of bits per QAM symbols	4
4	No. of sub blocks	1,2,4,8
5	No. of OFDM blocks	3000

3.2 Reduction of PAPR using SC-FDMA

There are three different subcarrier mapping schemes of SC-FDMA, localized FDMA (LFDMA), distributed FDMA (DFDMA) and interleaved FDMA (IFDMA). In the localized subcarrier mapping mode, the modulation symbols are assigned to adjacent subcarriers. In the distributed mode, the symbols are equally spaced across the entire channel bandwidth. IFDMA is a special case of SC-FMDA and it is very efficient in that the transmitter can modulate the signal strictly in the time domain without the use of DFT and IDFT [10].

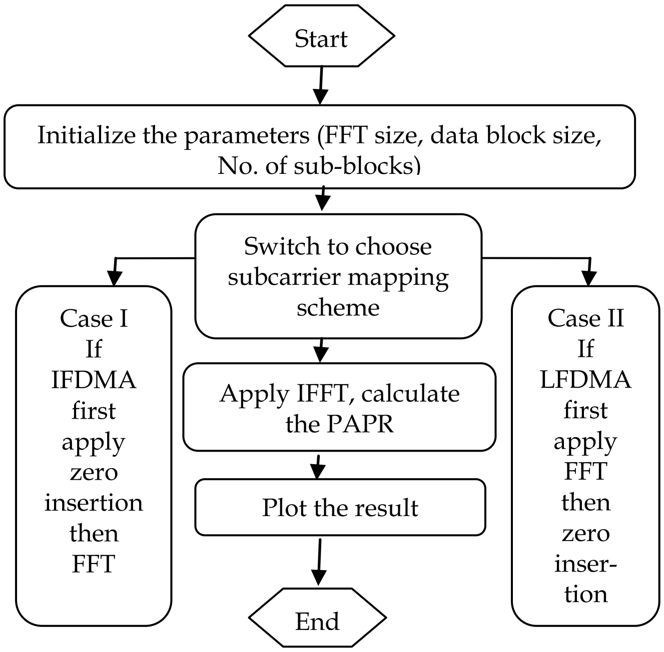

Fig. 2

The paper describes the IFDMA and LFDMA mapping schemes to show the PAPR value when DFT spreading technique is applied to IFDMA and LFDMA. In the DFT-spreading technique, M-point DFT is used for spreading, and the output of DFT is assigned to the subcarriers of IFFT. The effect of PAPR reduction depends on the way of assigning the subcarriers to each terminal. The flow chart of subcarrier mapping schemes of SC-FDMA used for PAPR reduction is given in fig. 2. Table 2 gives the parameters for IFDMA and LFDMA subcarrier mapping schemes of SC-FDMA. Here the FFT size is 128 and 64, number of data block size used are 32 and 16, number of iterations are 3000.

4 Result and Discussion

Matlab simulations are performed for 16QAM/OFDM system using PTS technique and IFDMA and LFDMA subcarrier mapping schemes of SC-FDMA to evaluate the performance of PAPR are discussed below:

TABLE 2

S.No	Parameter	Value
1	FFT size (N)	128,64
2	Data block size (M)	32,16
3	No. of OFDM blocks for iteration	3000

The simulation results compare the PAPR performance of 16QAM/OFDM system with FFT size = 128, 64, 32. Figure 3(a) shows the CCDF of PAPR for a 16-QAM/OFDM system using PTS technique as the number of sub block varies. The simulation is done with FFT size = 128.

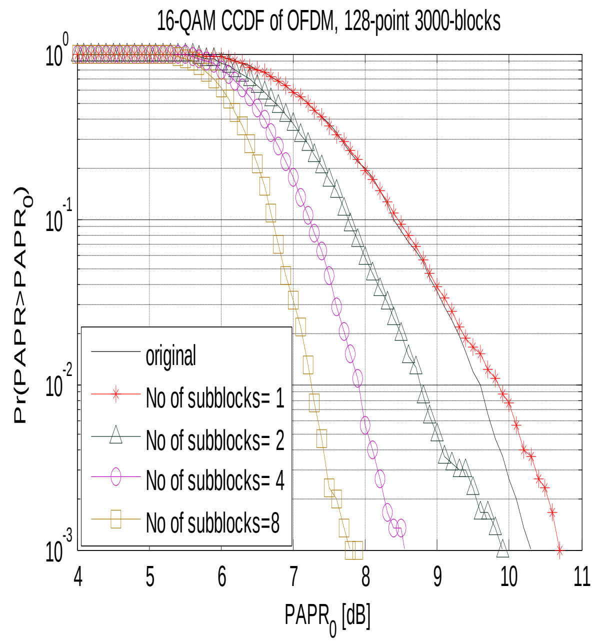

Fig. 3(a) *PAPR performance of a 16-QAM/OFDM system for FFT size = 128*

The table 3 shows the result of 16QAM/OFDM system using PTS technique. Here the result has been compared for different FFT size which shows that PAPR performance is improved at FFT size = 32. These next simulation results compare the PAPR performance when DFT- spreading technique is applied to the IFDMA and LFDMA. PAPR performance of the DFT-spreading technique varies depending on the subcarrier allocation method. Fig. 4(a) shows PAPR performance of IFDMA and LFDMA for 16QAM modulation technique when N = 128 and M = 32 and fig. 4(b) shows the PAPR performance of IFDMA and LFDMA for 16QAM with N = 64 and M = 16. The comparison of both the results reveals that PAPR performance is better for IFDMA than LFDMA.

FFT size	Subcarrier mapping scheme	PAPR in dB
128	IFDMA LFDMA	4.7 8.2
64	IFDMA LFDMA	5.0 7.8

TABLE 4

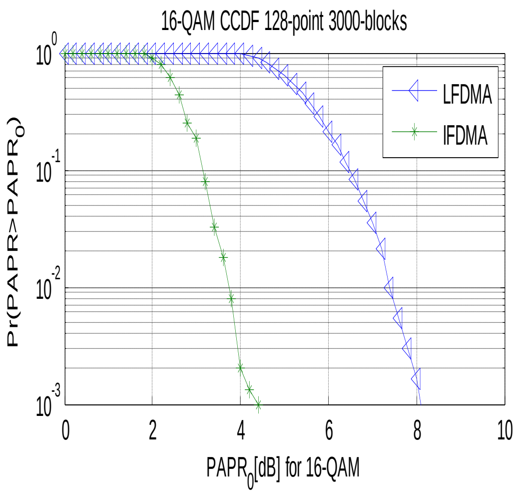

Fig. 4(a) *PAPR performance of DFT-spreading technique for IFDMA and LFDMA for FFT size = 128*

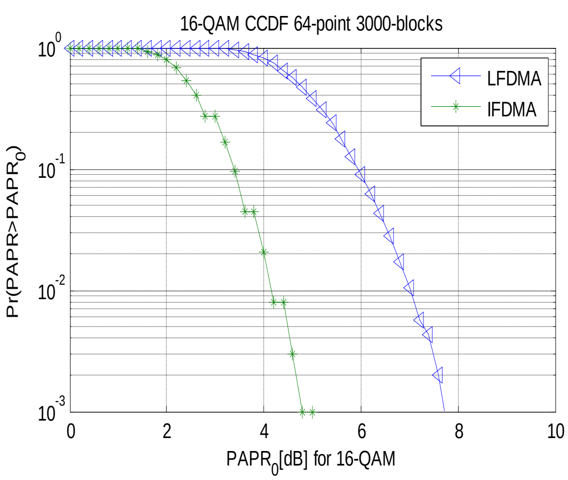

Fig. 4(b) *PAPR performance of DFT-spreading technique for IFDMA and LFDMA for FFT size = 64*

TABLE 3

FFT size	No. of sub blocks	PAPR in dB
128	8	7.9
64	8	7.1
32	8	6.7

Table 4 *compares the performance of IFDMA and LFDMA for FFT size 128 and 64. Comparison shows that IFDMA performs better than LFDMA.*

5 Conclusion

In this paper PAPR problem of OFDM system has been discussed. The various PAPR reduction techniques are introduced. The PTS and SC-FDMA techniques proposed in this paper gives the improved result of PAPR. The survey on various reduction techniques conclude that IFDMA performs better and lowers the PAPR value up to high extent. In this paper to reduce the PAPR the simulation results for 16QAM/OFDM system with PTS and subcarrier mapping schemes of SC-FDMA technique has been analyzed. First the result for PTS technique has been discussed. The result shows that as the number of sub blocks increases the PAPR value decreases and PAPR is lower for FFT size = 32 i.e 6.7 dB. Then, the subcarrier mapping schemes of SC-FDMA has been discussed. The comparison between two is done. The result shows that IFDMA performs better than LFDMA as PAPR for IFDMA is 4.7 dB and 5.0dB which is quite lesser than LFDMA. Thus SC-FDMA is efficient technique for uplink transmission as it performs better than OFDM and reduces the complexity.

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