# PAPR REDUCTION TECHNIQUE FOR 3GPP LTE OFDM SYSTEM BY J ROTATION

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***Abstract:*** *LTE (long term evolution) is the last step toward the 4th generation (4G) of radio technologies designed to increase the capacity and speed of mobile telephone networks. Where the current generation of mobile telecommunication networks are collectively known as 3G (for "third generation"), LTE is marketed as 4G. LTE uses Orthogonal Frequency Division Multiplexing (OFDM) for the downlink – that is, from the base station to the terminal. OFDM meets the LTE requirement for spectrum flexibility and enables cost-efficient solutions for very wide carriers with high peak rates. However, one of the main drawbacks of the OFDM modulation technique is the large peak-to-average power ratio (PAPR) of the transmitting signals. This high PAPR causes interference when the OFDM signals are passed through an amplifier which does not have enough linear range. Several PAPR reduction techniques such as magnitude clipping, block coding, and partial transmit sequence (PTS) and pulse shaping have been proposed to reduce the PAPR. In this paper, we evaluate PAPR reduction technique by changing the phase of some subcarriers. The cumulative distribution function (CDF) of the PAPR, which can be used to evaluate the PAPR reduction performance, is derived for OFDM signals.*

***Keywords:*** *3GPP, LTE, OFDM, CDF, and PAPR*

## 1. Introduction

Orthogonal frequency-division multiplexing (OFDM) scheme utilized as a digital multi-carrier modulation method. A large number of closely-spaced orthogonal sub-carriers are used to carry data. The data is divided into several parallel data streams or channels, one for each sub-carrier. Each sub-carrier is modulated with a conventional modulation scheme at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used in applications such as digital television and audio broadcasting, wireless networking and broadband internet access. The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions (for example, attenuation of high frequencies in a long copper wire, narrowband interference and frequency-selective fading due to multipath) without complex equalization filters. Channel equalization is simplified because OFDM may be viewed as using many slowly-modulated narrowband signals rather than one rapidly-modulated wideband signal. The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to handle time-spreading and eliminate intersymbol interference (ISI). This mechanism also facilitates the design of single frequency networks (SFNs), where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be combined constructively, rather than interfering as would typically occur in a traditional single-carrier system. An OFDM carrier signal is the sum of a number of orthogonal sub-carriers, with baseband data on each sub-carrier being independently modulated commonly using some type of quadrature amplitude modulation (QAM) or phase-shift keying (PSK). This composite baseband signal is typically used to modulate a main RF carrier. A serial stream of binary digits are first demultiplexed into N parallel streams, and each one mapped to a symbol stream using some modulation constellation . Note that the constellations may be different, so some streams may carry a higher bit-rate

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than others. An inverse FFT is computed on each set of symbols, giving a set of complex time-domain samples. These samples are then quadrature-mixed to pass band in the standard way. The real and imaginary components are first converted to the analogue domain using digital-to-analogue converters (DACs); the analogue signals are then used to modulate cosine and sine waves at the carrier frequency, , respectively. These signals are then summed to give the transmission signal. The receiver picks up the signal, which is then quadrature-mixed down to baseband using cosine and sine waves at the carrier frequency. The baseband signals are then sampled and digitized using analogue-to-digital converters (ADCs), and a forward FFT is used to convert back to the frequency domain. This returns N parallel streams, each of which is converted to a binary stream using an appropriate symbol detector. These streams are then re-combined into a serial stream, which is an estimate of the original binary stream at the transmitter. OFDMA has serious disadvantages such as high peak to average power ratio. For simplicity of operation we widely used Binary Phase Shift King (BPSK).BPSK is the simplest form of phase shift keying (PSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK. It does not particularly matter exactly where the constellation points are positioned. This modulation is the most robust of all the PSKs since it takes the highest level of noise or distortion to make the demodulator reach an incorrect decision. It is, however, only able to modulate at 1 bit/symbol and so is unsuitable for high data-rate applications when bandwidth is limited. In this paper, we will evaluate a probable way of reducing PAPR in OFDM by changing the phase of some of the subcarriers. The reduction of the PAPR is possible by cyclically rotate some of the subcarriers. This is flexible for high data rate communication with lower PAPR.

Rest of the paper is organized as follows: section 2.discussion of LTE system model, section 3. PAPR reduction techniques, section 4.simulation result, section 5.conclusion.

## 2. LTE OFDM System Model

A simplified block diagram of the 3GPP LTE OFDMA transmitter is shown in Fig. 1.

A baseband modulator transmits the binary input to a multilevel sequences of complex number x(k) in one of several possible modulation formats including, Binary phase shift keying (QPSK), and 16 level-QAM at the transmitter side. BPSK is the simplest form of phase shift keying (PSK. It uses two phases which are separated by 180° and so can also be termed 2-PSK. It does not particularly matter exactly where the constellation points are positioned. This modulation is the most robust of all the PSKs since it takes the highest level of noise or distortion to make the demodulator reach an incorrect decision. It is, however, only able to modulate at 1 bit/symbol and so is unsuitable for high data-rate applications when bandwidth is limited.

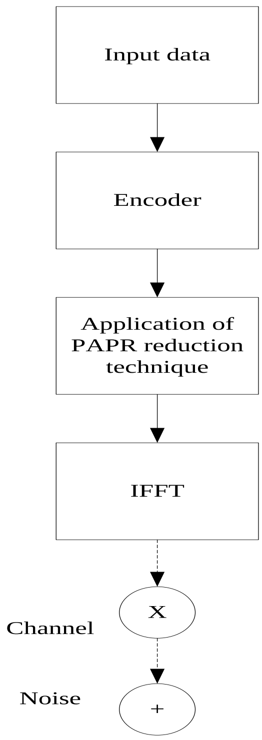


Fig. 1: 3GPP LTE OFDM Transmitter

These modulated symbols, are perform an N-point discrete Fourier transform (DFT) to produce a frequency domain representation [2]:

$$S_1(n)=\frac{1}{1} x(k)\, e^{\frac{(-j2\pi kn)}{N}} \qquad \ldots\ldots\ldots.. (1)$$

And inverse discrete Fourier transform for time domain expression:

$$x(k)=\frac{1}{J} S1(n)\, e^{\frac{(j2\pi kn)}{N}} \quad \ldots\ldots\ldots (2)$$

where k is the sample index, j is the imaginary unit, x is the discrete symbol and x(k)is the data symbol. Then cyclic prefix inserted and transmitted through the channel.

In the same way at the receiver side the signal is receive and the cyclic prefix is removed then this incoming signal is DFT and we get the base band signal after decoding, peak to average power ratio (PAPR) is a comparison of the peak power detected over a period of sample occurs over the same time period and defined as [8-10]:

$$\text{PAPR} = \frac{\max_{0<m<T} |s(m)|^2}{\frac{1}{TN}\int_0^{TN} |s(m)|^2\, dm}, \quad \ldots\ldots (3)$$

Where s(m) is the transmitted signal, T is the symbol period of the transmitted signal. Expression in decibels

$$\text{PAPR}_{dB}=10 \log_{10}(\text{PAPR}) \ldots\ldots\ldots\ldots (4)$$

One of the most frequently used performance measures for PAPR reduction techniques is cumulative distribution function (CDF). There is another performance parameter bit error rate analysis. Although QPSK can be viewed as a quaternary modulation, it is easier to see it as two independently modulated quadrature carriers.

With this interpretation, the even bits are used to modulate the in-phase component of the carrier, while the odd bits are used to modulate the quadrature-phase component of the carrier. BPSK is used on both carriers and they can be independently demodulated. Generally bit error rate of BPSK is lower than the QPSK.

### 3. PAPR Reduction Technique

There are several PAPR reduction techniques such as magnitude clipping, block coding, and partial transmit sequence (PTS) and pulse shaping have been proposed to reduce the PAPR. In this paper, we evaluate a changing the phase of some of the subcarriers for PAPR reduction. This phase changing can be done generally cyclic rotation by multiplication subcarriers by j. To measure the improvement there are several parameters we can use BER, PAPR, and SNR etc. Generally in this paper we discuss PAPR with multiplication j and without multiplication j of the subcarriers. Latter we will show that after multiplication j the PAPR reduce, this reduction can kept at consideration label by iterative method. Though it is very difficult to achieve high value PARR reduction, it is useable. The cumulative distribution function (CDF) of the PAPR, which can be used to evaluate the PAPR reduction performance, is derived for OFDM signal. In this method the input signal is at first grouping and then rotates the signal by multiplying j. This is useful to reduce PAPR as our desired purpose. Here we can use both BPSK and QPSK generally we use BPSK several time for many reasons such as bit error rate of BPSK is lower than the QPSK, to reduce computational complexity etc though it has many disadvantages also. Then the signal is converted into time domain by IFFT. This signal PAPR is lower compare to the original signal PAPR. To compute PAPR with rotation initialization of FFT size, number of data subcarriers, number of symbols. Then there is needed generate random signal and grouping. Then rotate the signal by multiplication by j cyclically. Then this signal is converted into time domain by IFFT. On the other hand without multiplication by j the signal is converted into time domain by IFFT. Then compute PAPR and compare the PAPR. if the PAPR with multiplication by j is lower than without multiplication then the signal is ready to transmit and then other performance parameters can be checked. This is compare by simulation using the flow chart scheme as shown in figure2. In practically instead of generate random signal which is used in computer simulation we have readily available signal which is needed to communication.

Therefore the transmitted signals PAPR lower compare to the original signal. Which improve the average transmitted power, reduce power consumption level, improved efficiency of the transmitter.

## 4. Simulation Result

Cumulative distribution function (CDF) of PAPR, which is the probability that PAPR is higher than a certain PAPR value. The parameters used for the calculation of PAPR are illustrated in Table1.

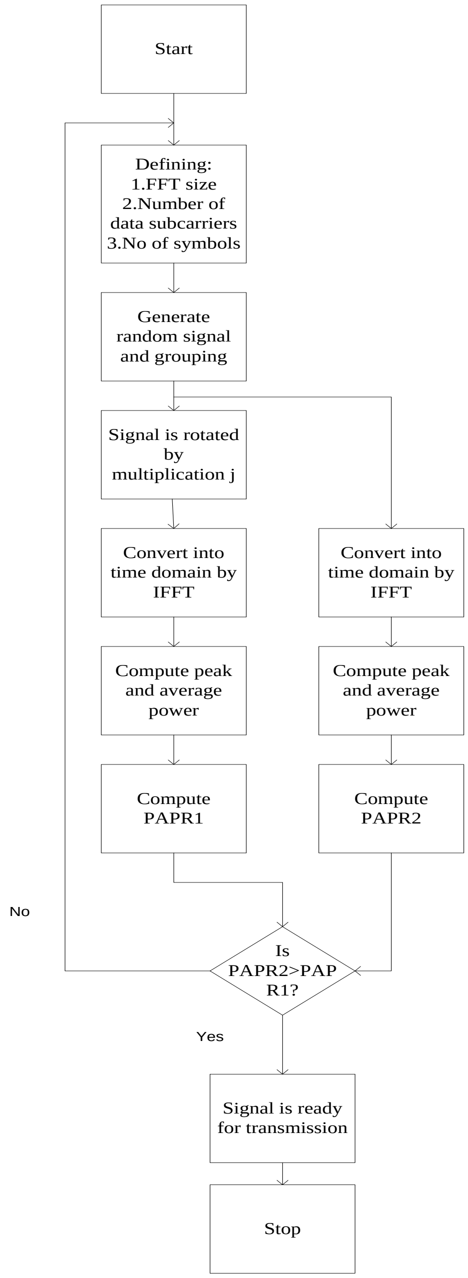


Fig. 2: Flow Chart scheme

Table1: The system parameters used for simulations

| | |
|---|---|
| Number of data subcarriers | 114 |
| SIZE OF FFT | 128 |
| Modulation | BPSK |
| Number of symbols | 10^4 |

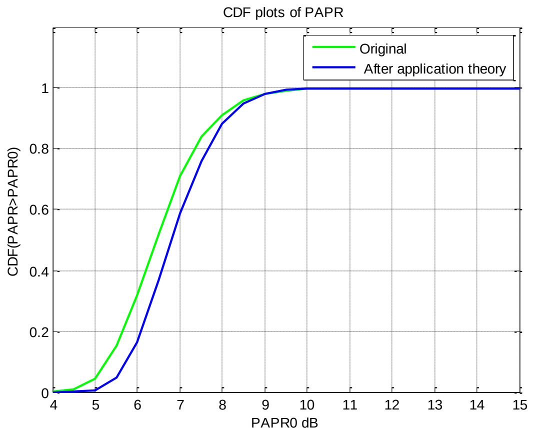


Fig. 3: Comparison of CCDF of PAPR for OFDM PAPR with j Rotation

The simulation result of this method is shown in figure2. It can be observe that OFDM signal is has higher PAPR and after applying this method PAPR is reduced significantly. In this figure for 7 value of PAPR0 OFDM signal corresponding CDF value is .7 whereas after applying this theory the CDF come .6.

This PAPR reduce due to the phase rotation of the some subcarriers. Therefore it reduces PAPR significantly as well as increase average transmitted power, improve amplifier efficiency and reduced cost.

## 5. Conclusion

This paper has introduced PAPR reduction technique by multiplication j(j rotation) of an OFDM signal. We compare the PAPR characteristics using CDF of PAPR. The simulation result shows that PAPR after applying this theory is lower than the original signal PAPAR. As a result average transmitted power is increase and improves the transmitter efficiency, reduce the cost.

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