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Logarithmic Companding for PAPR Reduction in OFDM

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ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) is taken into account to be a promising technique against the multipath attenuation channel for wireless communications. However, OFDM faces the Peak-to-Average Power magnitude relation (PAPR) downside that's a significant downside of multicarrier gear that results in power unskillfulness in RF section of the transmitter. This paper gift completely different PAPR reduction techniques ANd conclude an overall comparison of those techniques. we have a tendency to additionally simulate the chosen mapping technique (SLM) for various route range that is most effective technique for PAPR reduction once the amount of subcarrier is massive. Simulation shows that the PAPR downside reduced because the route range will increase.

Keywords*: Orthogonal Frequency Division Multiplexing (OFDM), Peak-to-Average Power Ratio (PAPR), Power Amplifiers (PAs), Selected Mapping (SLM), Complementary Cumulative Distribution Function (CCDF)*

I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) technology is one of the most attractive candidates for fourth generation (4G) wireless communication. It effectively combats the multipath fading channel and improves the bandwidth efficiency. At the same time, it also increases system capacity so as to provide a reliable transmission [1]. OFDM uses the principles of Frequency Division Multiplexing (FDM) [1] but in much more controlled manner, allowing an improved spectral efficiency [1].

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.

OFDM faces several challenges. The key challenges are ISI due to multipath-use guard interval, large peak to average ratio due to non linearity‟s of amplifier; phase noise problems of oscillator, need frequency offset correction in the receiver. Large peak-to-average power (PAP) ratio which distorts the signal if the transmitter contains nonlinear components such as power amplifiers (PAs). The nonlinear effects on the transmitted OFDM symbols are spectral spreading, inter modulation and changing the signal constellation. In other words, the nonlinear distortion causes both in-band and out-of-band interference to signals. Therefore the PAs requires a back off which is approximately equal to the PAPR for distortion-less transmission. This decreases the efficiency for amplifiers. Therefore, reducing the PAPR is of practical interest. Many PAPR reduction methods have been proposed. Some methods are designed based on employing redundancy, such as coding [4], [5], selective mapping with explicit or implicit side information [6], [3], [5], or tone reservation [10], [12]. An apparent effect of using redundancy for PAPR reduction is the reduced transmission rate. PAPR reduction may also be achieved by using extended signal constellation, such as tone injection [10], or multi-amplitude CPM. The associated drawback is the increased power

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and implementation complexity. A simple PAPR reduction method can be achieved by clipping the time-domain OFDM signal. In this work, we survey the PAPR reduction techniques for OFDM. We also present PAPR reduction technique based on selective mapping (SLM) under different route number M.

PAPR IN OFDM:

Let y(0),y(1),….,y(N −1) represent the data sequence to be transmitted in an OFDM symbol with N subcarriers. The baseband representation of the OFDM symbol is given by:

y(t) = $0 \leq t \leq T$ (1)

where T is the duration of the OFDM symbol. According to the central limit theorem, when N is large, both the real and imaginary parts of (t) become Gaussian distributed, each with zero mean and a variance of $E[y(t)^2]/2$, and the amplitude of the OFDM symbol follows a Rayleigh distribution. Consequently it is possible that the maximum amplitude of OFDM signal may well exceed its average amplitude. Practical hardware (e.g. A/D and D/A converters, power amplifiers) has finite dynamic range; therefore the peak amplitude of OFDM signal must be limited. PAPR is mathematically defined as:

PAPER=$10\log_{10}$ (dB) (2)

It is easy to see from the equation that PAPR reduction may be achieved by decreasing the numerator or increasing the denominator or both. The effectiveness of a PAPR reduction technique is measured by the complementary cumulative distribution function (CCDF), which is the probability that PAPR exceeds some threshold,

i.e.: CCDF = Probability(PAPR >), where is the threshold.

II. PAPER REDUCTION TECHNIQUES

Partial transmit sequence

Partial Transmit Sequence (PTS) is one in every of the foremost economical techniques to diminish PAPR. during this theme original OFDM signal is split into variety of sub-blocks. Then part rotation is accessorial to develop variety of signal and opt for one with lowest PAPR [6].

Block coding technique

Block writing is that the straight forward technique to diminish PAPR. Basic plan behind it's to pick code words with low peak power when writing from all probable symbols. With N sub-carrier QPSK modulation provides a pair of 2N bits and so 2N messages [7].

Selective mapping

Selective Mapping is promising technique to mitigate PAPR in OFDM system. Fundamental idea behind scheme is phase rotation. Signal with low PAPR is selected from different independent phase sequences that have same information at transmitter [2].

Tone reservation

This is an accurate method for PAPR mitigation. Amount of PAPR mitigation relies on some factor such as number of reserved tones, location of reserved tones, and amount of complexity and allow power on reserved tones.

Signal distortion techniques

Clipping and Filtering [2][9][10], Peak Windowing [11], Envelope Scaling etc. are signal distortion techniques.

ISSN 2348 – 8034
Impact Factor- 3.155

Clipping and filtering

The simplest technique of PAPR reduction is clipping whose fundamental process to clip the part of signal which is out of allowed region with high peak [9].

Peak windowing

With this technique it is possible to remove larger peaks at the rate of a little amount of interference when large peaks arise infrequently. It mitigates PAPR at cost of increases BER (bit-error-rate) and out-of-bands radiation. It provides better PAPR mitigation with better spectral properties.

Envelope scaling

Objective of this algorithmic rule is to mitigate PAPR by scaling. Input envelope for few subcarrier before IFFT operation. Here 256 subcarriers with QPSK modulation technique area unit accustomed certify envelope for all subcarrier area unit equal. Per algorithm input envelope in some sub-carrier is scaled to realize the littlest quantity of PAPR at IFFT output. Thus, at receiver there's no would like of facet info for coding purpose. PAPR reduces to 4db with same algorithmic rule. If QAM is used variety of sub-carrier can massive then have to be compelled to send excessive facet info otherwise BER assign in great amount.

Table -1: Comparison of PAPR Reduction Techniques

Reduction Technique	Parameters			**Operation required at Transmitter (TX) / Receiver (RX)**
	Decrease distortion	**Power raise**	**Defeat data rate**	
Clipping and Filtering	No	No	No	TX: Clipping RX: None
Selective Mapping(SLM)	Yes	No	Yes	TX: M times IDFTs operation RX:Side information extraction, inverse SLM
Block Coding	Yes	No	Yes	TX: Coding or table searching RX: Decoding or table searching
Partial Transmit Sequence(PTS)	Yes	No	Yes	TX: V times IDFTs operation RX: Side information extraction, inverse PTS
Interleaving	Yes	No	Yes	TX: D times IDFTs operation, D-1 times interleaving RX:Side information extraction, de-interleaving
Tone Reservation(TR)	Yes	Yes	Yes	
Tone Injection(TI)	Yes	Yes	No	

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Impact Factor- 3.155

III. PROPOSED TECHNIQUE

The proposed technique uses the PTS and the companding technique to reduce the PAPR. In the compading technique the signal is compressed at the transmitter end and the signal is expanded at the receiver end. The Logarithm Function (log) Companding is used in this work. The logarithm (log e) companding function is defined by C(x) = k1 loge(1+k2x) where k1 and k2 are two positive numbers controlling the amount of companding. The whole process is explained by the following algorithm.

Proposed algorithm

Step-1: The sequence of data bits is modulated using QPSK to produce sequence symbols I0, I1.

Step-2: These symbol sequences are divided into blocks of length 256(/N). Here, N(256) is the number of sub-carriers.

Step-3: Take IFFT to convert the frequency domain signal to the time domain.

Step -4: Multiply each sub-block by choosing the random phase sequence from [1 -1 j –j].

Step - 5: Apply Logarithm Function for companding

$C(x) = k_1 \log_e(1+k_2x)$

where k_1 and k_2 are two positive numbers controlling the amount of companding

Step-6: Select the one, which has the minimum PAPER.

The PAPR reduction technique should be chosen with awareness according to various system requirements.

IV. RESULT & DISCUSSION

In this section the PAPR reduction performance of the proposed technique is analyzed. This Proposed technique is also compared with the PTS technique. Simulation has been done in MATLAB and following parameters have been considered for simulation purpose:

Table-2: Simulation parameter used in companding technique

Simulation parameters	**Type/Value**
Number of subcarriers (N)	64,32
Oversampling factor(L)	4,2
Modulation Scheme	QPSK
Phase factor	[1,-1,j,-j]

In simulations, an OFDM system is considered with number of sub-carriers (N=64) and N=32, over-sampling factor (L=2) and L=4 and QPSK Modulation. The phase factor is chosen as {1,-1, j, -j}.

ISSN 2348 – 8034
Impact Factor- 3.155

Fig.4.3 to Fig.4.6 show the graphs for the complement cumulative distribution function (CCDF) of PAPR in original PTS and Proposed technique for the different cases of N=64 and L=4 , N=32 and L=4 , N=64 and L=2, N=32 and L=2 respectively.

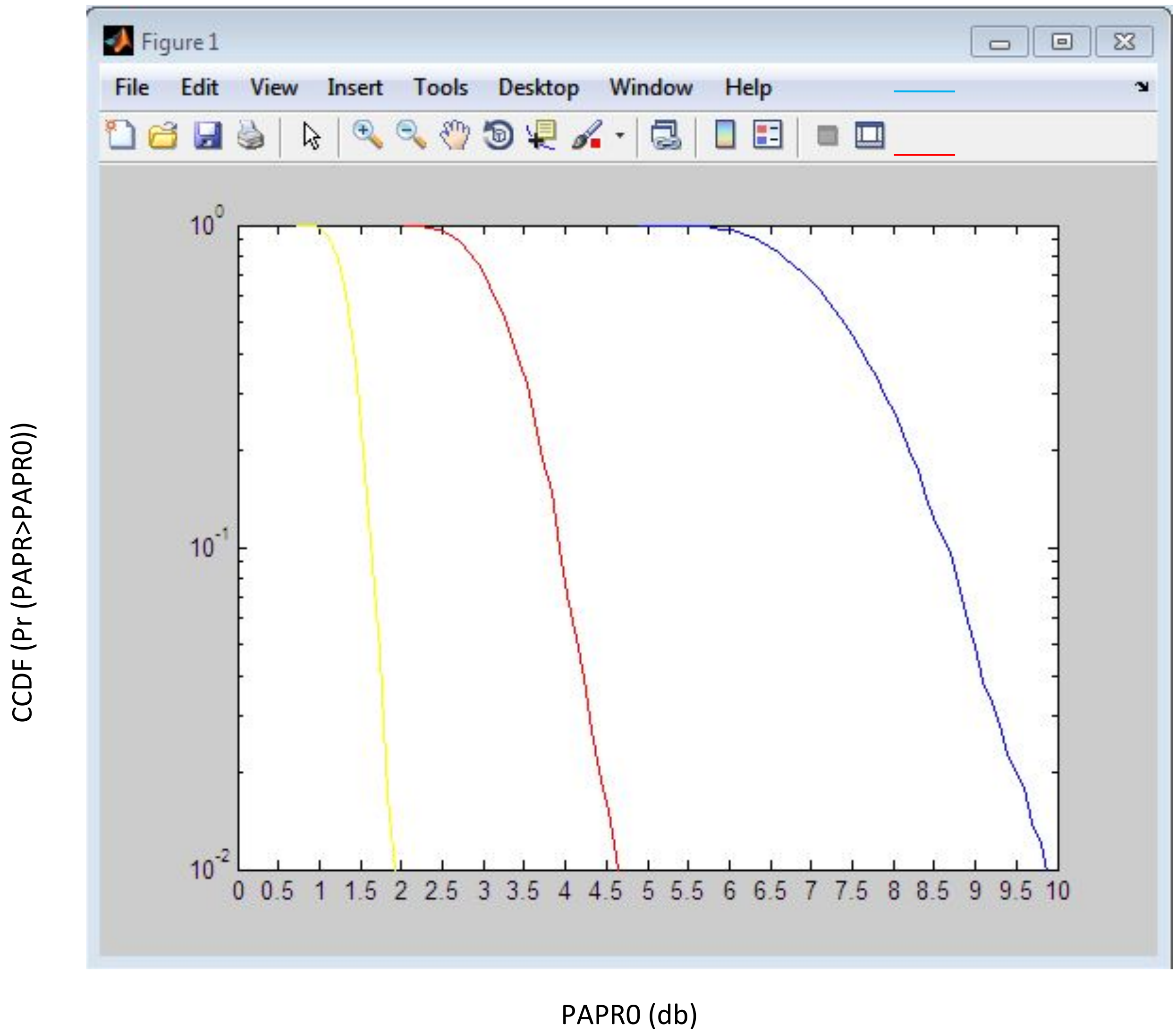

Fig.1.1 CCDF Of PAPR In Proposed Technique Versus Standard PTS With N=64 And L=4 And QPSK Modulation

ISSN 2348 – 8034
Impact Factor- 3.155

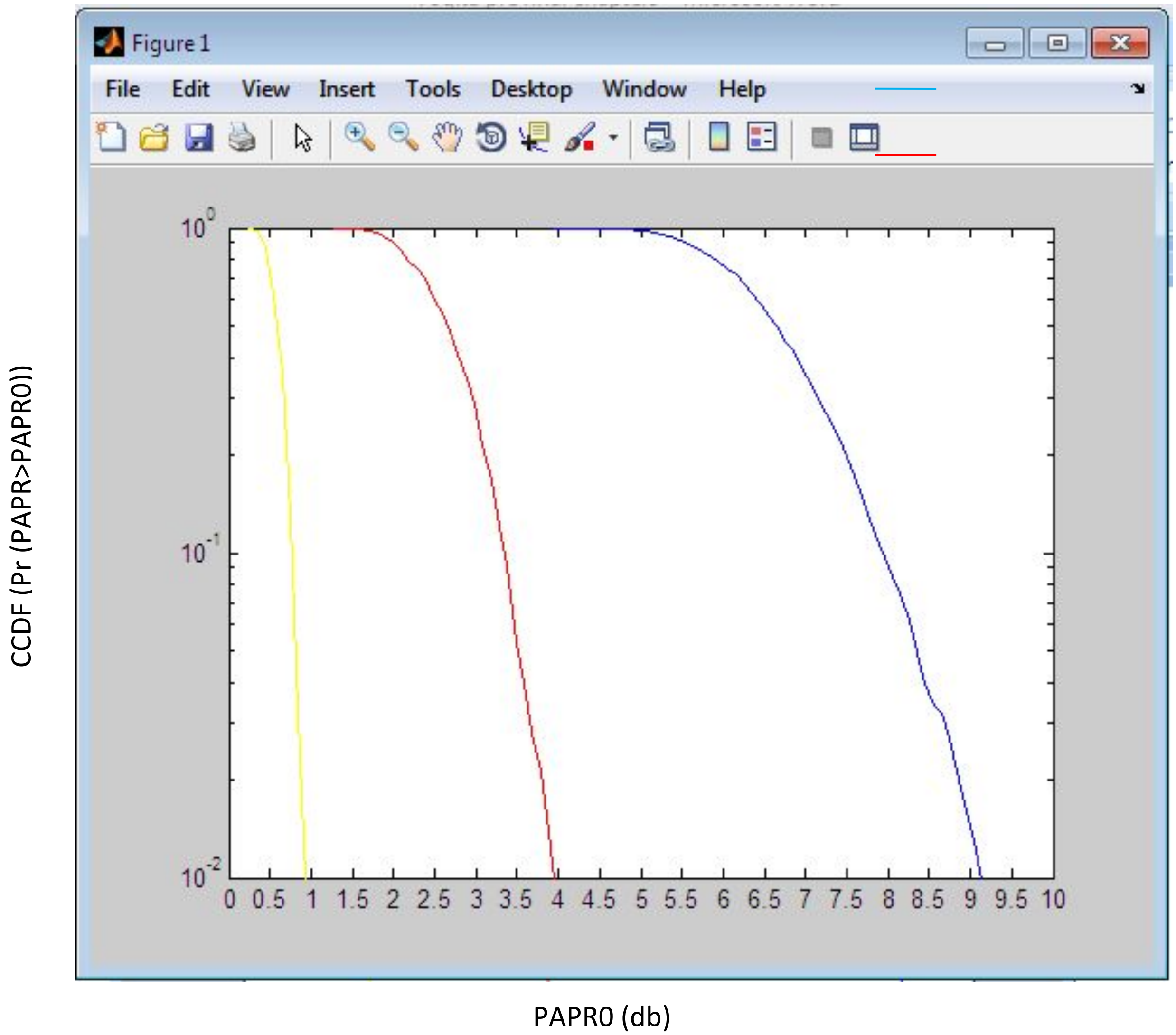

Fig.1.2. CCDF Of PAPR In Proposed Technique Versus Standard PTS With N=64, L=2, QPSK Modulation

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Impact Factor- 3.155

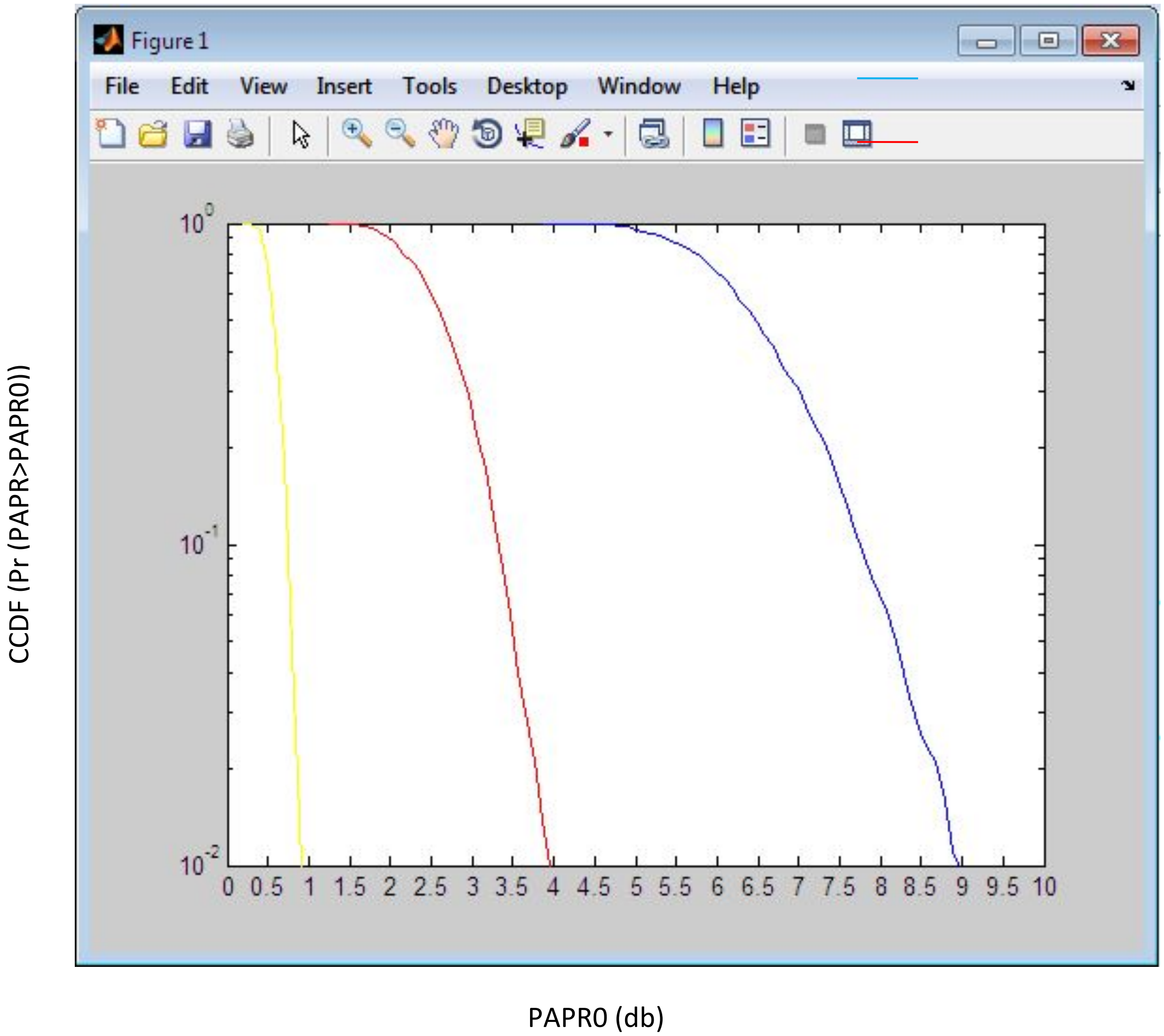

Fig.1.3. CCDF Of PAPR In Proposed Technique Versus Standard PTS With N=32, L=2, QPSK Modulation

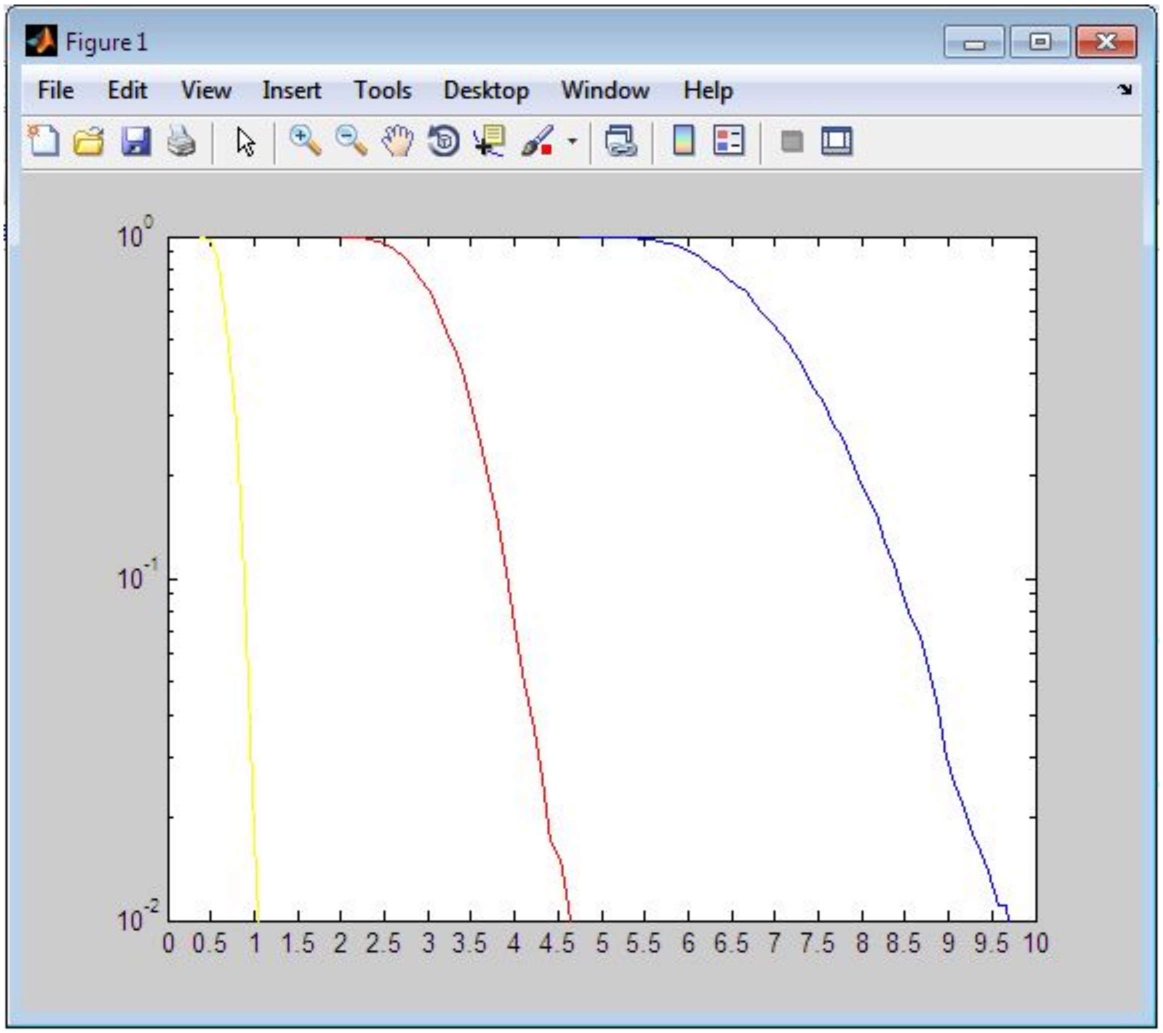

Fig.1.4 CCDF of PAPR in proposed technique versus standard PTS with N=64, L=2, QPSK modulation

V. CONCLUSION

In this dissertation, the proposed technique uses the PTS and the companding technique to reduce the PAPR. In the compading technique the signal is compressed at the transmitter end and the signal is expanded at the receiver end. The Logarithm Function (log) Companding is used in this work. The logarithm (log e) companding function is defined by $C(x) = k_1 \log_e(1+k_2x)$ where k_1 and k_2 are two positive numbers controlling the amount of companding. The simulation results show that the PAPR is reduced to a great extent by the proposed technique. The comparison is done on the N=64 and N=32 sub bands with oversampling factor 2,4. In all cases the PAPR is reduced more than 50 % of the PAPR of PTS technique. The PTS technique already have reduced PAPR, this confirms the better performance of the proposed algorithm. Moreover, the proposed algorithm doesn't increase the complexity of system. So the PAPR is reduced without increasing the complexity of the system

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REFERENCES

1. *V. Vijayarangan & R. Sukanesh, "An Overview Of Techniques For Reducing Peak To Average Power Ratio And Its Selection Criteria For Orthogonal Frequency Division Multiplexing Radio Systems", Journal of Theoretical & Applied Information Technology, Vol. 5 (1), 2012.*
2. *A. Eltholth, A. R. Mekhail, A. Elshirbini, M. I. Dessouki & A. I. Abdelfattah. "Modeling the Effect of Clipping and Power Amplifier Non-Linearities on OFDM Systems", Ubiquitous Computing and Communication Journal, Vol. 3(1), pp. 54-59, 2012.*
3. *V. Arasu, , P. Hyanki, , H. L. Sharma, G. Lakshminarayanan, M. H.Lee, & S. B. Ko, "PAPR reduction for improving performance of OFDM system", Proceeding on IEEE International Conference on Communication Control and Computing Technologies (ICCCCT), pp. 77-82, October, 2013.*
4. *B. Farhang-Boroujeny & C. H. Yuen 2010), "Cosine modulated and offset QAM filter bank multicarrier techniques a continuous-time prospect", EURASIP Journal on Advances in Signal Processing, vol. 6, issue 1, December, 2014.*
5. *A. Sharif, V. M. Potdar & R. F. Ahmad, "Adaptive channel coding and modulation scheme selection for achieving high throughput in wireless networks", IEEE 24th International Conference on Advanced Information Networking and Applications Workshops (WAINA), pp. 200-207, April, 2010.*
6. *D. W. Lim, , S. J. Heo, J. S. & H.Chung, "On the phase sequence set of SLM OFDM scheme for a crest factor reduction", IEEE Transactions on Signal Processing, vol. 54(5), pp.1931-1935, 2012.*
7. *C. R. Anthikkad & I. A. BAIG, "Performance Enhancement Of Ofdm In Papr Reduction Using New Companding Transform And Adaptive Ac Extension Algorithm For Next Generation Networks", International journal in Electrical Engineering, vol. 6 (2), Febuary,2013.*
8. *D. S. Waldhauser, L. G. Baltar & J. A. Nossek, "Comparison of filter bank based multicarrier systems with OFDM", IEEE Asia Pacific Conference on Circuits and Systems, pp. 976-979, December, 2014.*
9. *N. J. LaSorte, W. J. Barnes & H. H. Refai, "The History of Orthogonal Frequency Division Multiplexing", In GLOBECOM , pp. 3592-3596, December, 2008.*
10. *V. Vijayarangan & R. Sukanesh, "An overview of techniques for reducing peak to average power ratio and its selection criteria for orthogonal frequency division multiplexing radio systems", Journal of Theoretical & Applied Information Technology, vol. 5(1). Jan, 2013.*
11. *C. P. Li, S. H. Wang, & C. L.Wang, "Novel low-complexity SLM schemes for PAPR reduction in OFDM systems", IEEE Transactions on Signal Processing, vol. 58(5), pp. 2916-2921, October, 2012.*
12. *C. V. Arasu, P. Hyanki , H. L. Sharma, G. Lakshminarayanan, M. H. Lee & S. B. Ko, "PAPR reduction for improving performance of OFDM system", IEEE International Conference on Communication Control and Computing Technologies (ICCCCT), pp. 77-82, October, 2011.*
13. *C. Tellambura, "Improved phase factor computation for the PAR reduction of an OFDM signal using PTS", IEEE Communications Letters, vol. 5(4), pp. 135-137, 2001.*
14. *B. S. Krongold & D. L. Jones, "PAR reduction in OFDM via active constellation extension", Broadcasting, Journal of Communication, vol. 49(3), pp. 258-268, June, 2003.*