IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101007

Performance Analysis of PAPR reduction in OFDM on USRP-SDR platform

Ubendran.V [1], Dr.V. Mohan[2], Dr.M. Santhi[3]

Under-Graduate Student, Dept. of Electronics and Communication, Saranathan College, Trichy, India [1]

Associate Professor, Dept. of Electronics and Communication, Saranathan College, Trichy, India[2]

Professor and Head, Dept. of Electronics and Communication, Saranathan College, Trichy, India[3]

Abstract: Numerous compression strategies have been developed as a result of the work of different researchers. It has been observed that a signal's entropy has an impact on its compressibility. If there are few coefficients in the energy distribution, compressibility is high. This paper focused on peak to average power ratio (PAPR) reduction scheme for OFDM system. OFDM has several properties which make it an attractive modulation scheme for high speed transmission. The main drawback of OFDM is high PAPR. The high PAPR causes the interference and degraded the performance of the system while OFDM signal pass through the amplifier. Here a simple scheme, clip and filter is used to reduce the PAPR of OFDM system. The compressed signal is transmitted and received using OFDM system. This process is carried out using Software Defined Radios **(**USRP-SDR)

Keywords: NISDR, PAPR, clipping and filtering method, partial transmit sequence technique and selective mapping technique.

I. INTRODUCTION

With the advancements in communication networks, one can witness an increase in the transmission of digital multimedia and images around the world [1-2]. The speed of computation has always been considered as a weak link in the area of data compression. However, the currently evolving technology has forced onto focusing on limitations in storage capacity [3]. Orthogonal Frequency Division Multipex (OFDM) is a multicarrier modulation method with orthogonality of individual subcarriers [4]. An inherent property of MC transmission schemes is the high dynamic range of the transmitted signal. The theoretical value of the PAPR is given by the number of subcarriers in use. The probability of having such high peaks is marginal in systems with enough subcarriers, but still in practice the PAPR of MC signals is much higher than in case of single carrier signals [5]. The high dynamic range of the MC signals causes a problem in most communication systems, since the signal has to be amplified by a power amplifier (PA) at the transmitter. Practical PAs do not maintain linearity over the whole dynamic range of the MC signal, thus amplifying different parts of the signal differently. This distorts the MC signal, resulting in a reduced bit error rate (BER) performance and also in a spectral re growth, basically radiating energy at frequencies adjacent to the signal and at higher values than originally planned [5].

II. PAPR REDUCTIONTECHNIQUE

The Peak to Average Power Ratio (PAPR) [4] of a transmitted signal s(t) on time interval τ is defined by following relationship in eq.(1).

$$PAPR\{s(t),\tau\} = \frac{\max[s(t)]^2}{E\{[s(t)]^2\}} \qquad (1)$$

where max $[s(t)]^2$ denotes the peak signal power and E $\{[s(t)]^2\}$ is the average signal power.
Amplitude clipping is said to be the simplest method that may be used to reduce PAPR in an OFDM system. In this instance, a threshold amplitude value is set to restrict the peak of the input signal's envelope. Signals with values over this preset value are clipped, and the others are let to proceed unimpeded [6]. This clipping limits the peak of the input signal to a fixed value or otherwise passes the input signal through unperturbed with phase left unchanged . The clipped signal is defined by eq.(2).

ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⋇ Impact Factor 7.12 ⋇ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101007

$$B(x) = \begin{cases} x, & |x| \le A \\ Ae^{j\phi(x)} & |x| > A \end{cases} \qquad (2)$$

where B(x) denotes the amplitude value after clipping. x denotes the initial signal value, A is the threshold set by the user for clipping the signal. The issue here is that the system exhibits amplitude clipping distortion, which can be seen as an additional source of noise. Both inside and outside of the band, the distortion occurs. The in-band distortion cannot be reduced by filtering, and a decline in error performance. On the other side, out of band radiation reduces spectral efficiency. Filtering after clipping can reduce out-of-band radiation, but it may cause some peak regrowth. To address this issue, a repeated filtering and clipping procedure can be used. In order to attain the appropriate amplitude level ,this technique must be repeated multiple times.

One of the criteria, most frequently used to assess the effectiveness of any PAPR method is the Cumulative Distribution Function (CDF). Instead of using CDF, CCDF is employed [9], which is useful to measure the probability that the PAPR of a certain data block exceeds the given threshold.

Implementing the Central Limit Theorem for a multi – carrier signal with a large number of subcarriers, the real and imaginary part of the time – domain signals have a mean of zero and a variance of 0.5 and follow a Gaussian distribution. So, Rayleigh distribution is followed for the amplitude of the multi – carrier signal, where as a central chi-square distribution with two degrees of freedom is followed for the power distribution of the system. The CDF of the amplitude of a signal sample is given by eq.(3) and (4).

$$F(z) = 1 - \exp(z) \qquad (3)$$

$$\begin{aligned} P(PAPR > z) &= 1 - P(PAPR \le z) \\ &= 1 - F(z)^{N} \\ &= 1 - (1 - \exp(z))^{N} \end{aligned} \qquad (4)$$

Equations (3) and (4) assume that the N time domain signal samples are mutually independent and uncorrelated.

III . IMPLEMENTATION

I. Description of NI-USRP-SDR Platform

Universal Software Radio Peripheral (USRP) is a range of software-defined radios designed and sold by Ettus Research and its parent company, National Instruments. Most USRPs connect to a host computer through a high-speed link, which the host-based software uses to control the USRP hardware and transmit/receive data. Some USRP models also integrate the general functionality of a host computer with an embedded processor that allows the USRP device to operate in a stand-alone fashion. The USRP family was designed for accessibility, and many of the products are open source hardware. The board schematics for select USRP models are freely available for download; all USRP products are controlled with the open source UHD driver, which is free and open source software. USRPs are commonly used with the GNU Radio software suite to create complex software-defined radio systems.

FIG 1: USRP-SDR

ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⋇ Impact Factor 7.12 ⋇ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101007

II. IMPLEMENTATION OF THE PROPOSED SYSTEM

For simulation the parameters such as IFFT bin length, carrier count, bits per symbol, symbols per carrier,SNR were taken as 1024,24,16,1024,30dB respectively. The baseband signal length for transmission is computed by (carrier count * symbols per carrier* bits per symbol). The carrier and conjugate carriers were also calculated. In Transmitter side, the baseband signal is generated, then the data is converted from serial to parallel by reshaping the carrier matrix. The differential coding is converted to phase which is then converted into complex number. Each carrier is assigned to IFFT bin. The OFDM signal for one bit, OFDM carrier phase, carrier frequency magnitude were depicted in figure 6,7 and 8 respectively.

The channel used is additive white gaussian noise channel(AWGN).In order to maintain the prescribed SNR the noise of required level is added. At the receiver side the serial data is converted to parallel data. The OFDM received signal spectrum magnitude and received signal spectrum phase is depicted in figure 10 and 11 respectively.

For the purpose of reducing the PAPR the amplitude is clipped off to defined value by employing amplitude clipping techniques. The PAPR of the original OFDM and the clipped signal is calculated. Also by utilizing the partial transmit sequence technique and selective mapping
technique the PAPR is reduced. Figure 12 shows the clipped signal. The comparison of these three PAPR reduction techniques were depicted in figure 13 and fig 14.

III. Proposed System

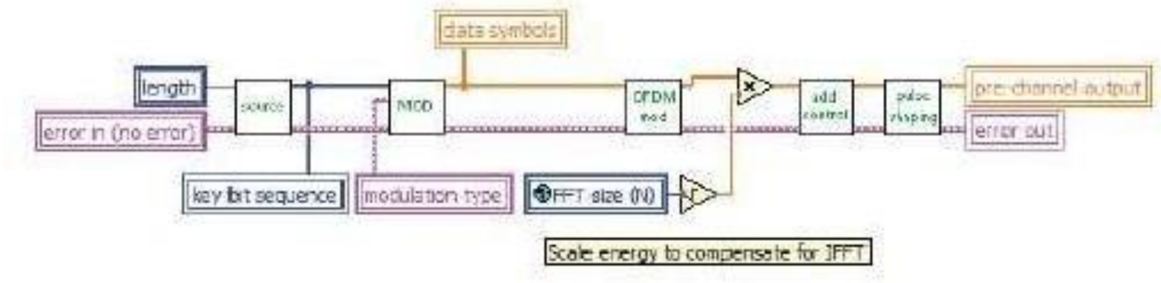

FIG 2: OFDM TRANSMITER

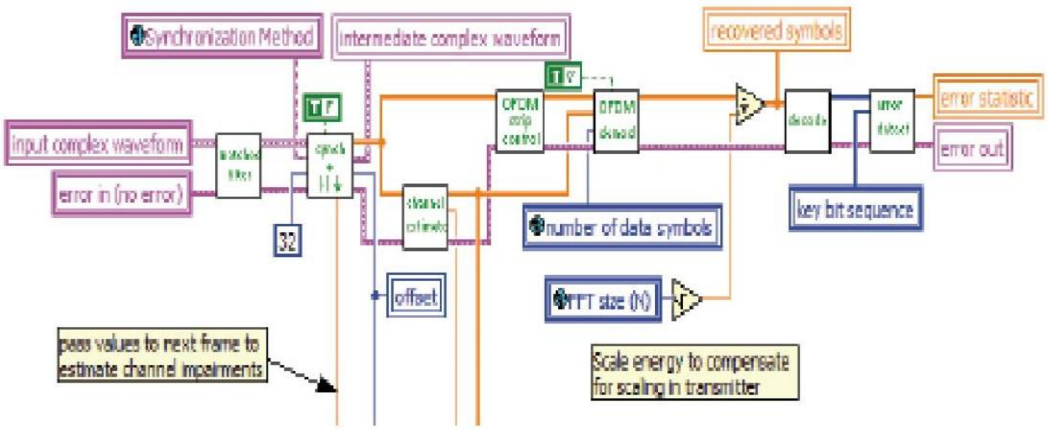

FIG 3: OFDM RECEIVER

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101007

IV. RESULTS OF SIMULATION

The proposed system is implemented using NI LabView software. The transmitter and receiver systems are designed using NI-USRP-SDR. The system is simulated and the layout and results of simulation were depicted in figure 4 and 5. Fig 4 depicts the simulation of OFDM Transmitter and its results. Fig 5 depicts the simulation of OFDM Receiver and its results.

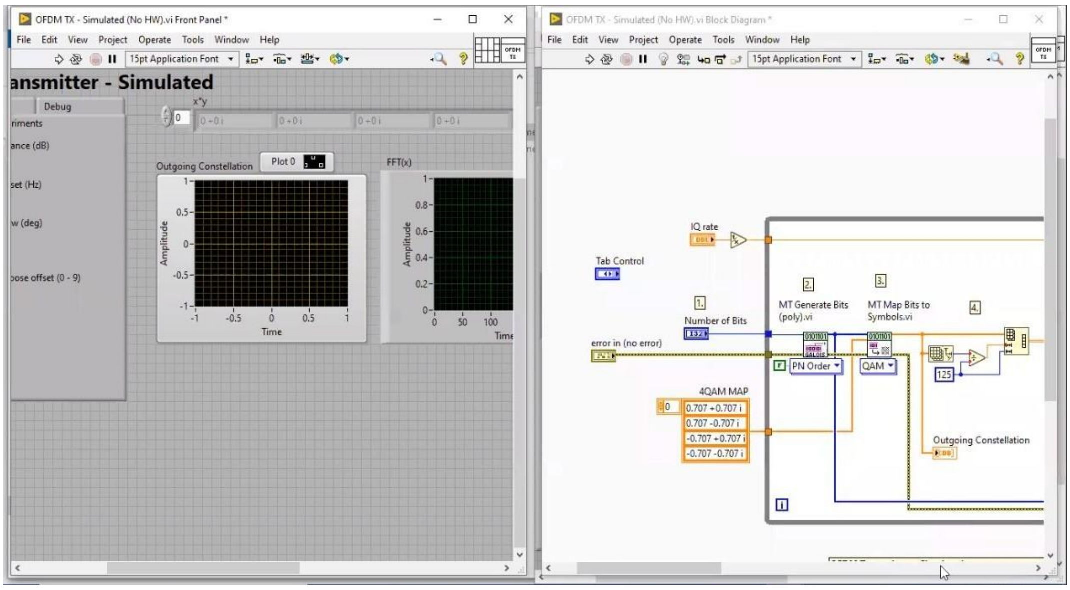

FIG 4 SIMULATION OF OFDM TRANSMITTER

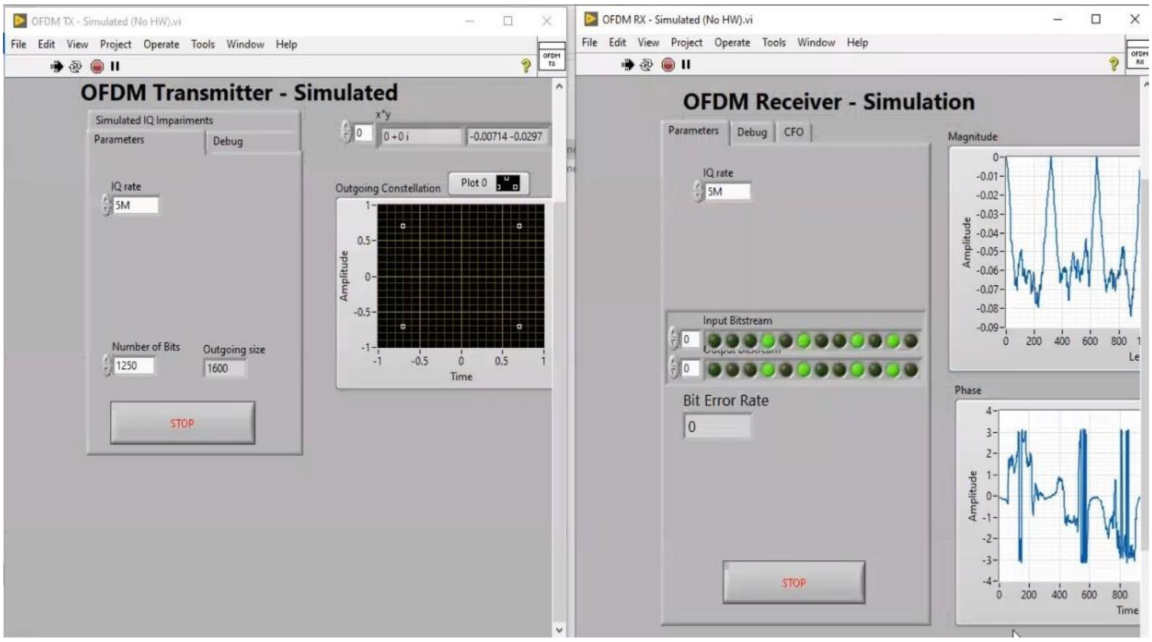

FIG 5 SIMULATION OF OFDM RECEIVER

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
ISO 3297:2007 Certified ⚟ Impact Factor 7.12 ⚟ Vol. 10, Issue 10, October 2022
DOI: 10.17148/IJIREEICE.2022.101007

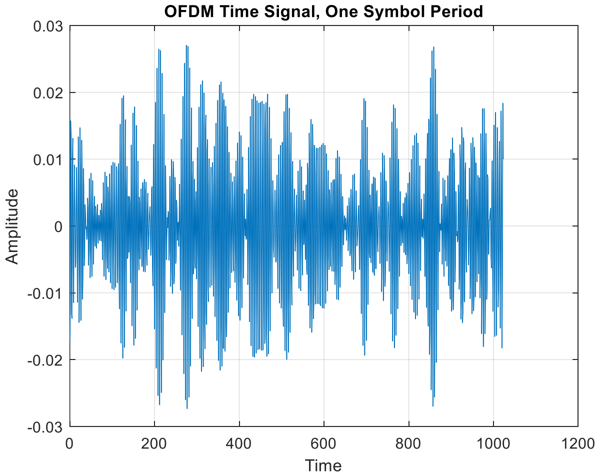

FIG 6: OFDM TIME SIGNAL

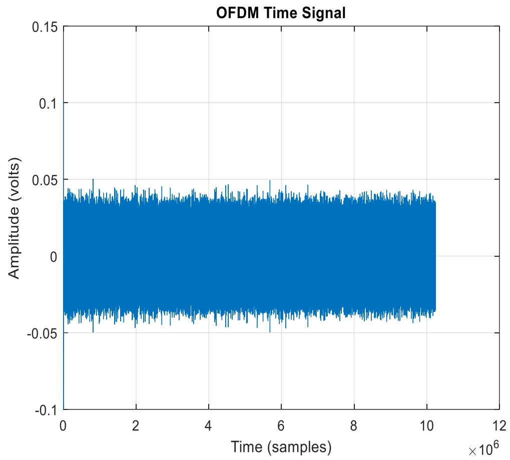

FIG 7: OFDM CARRIER PHASE

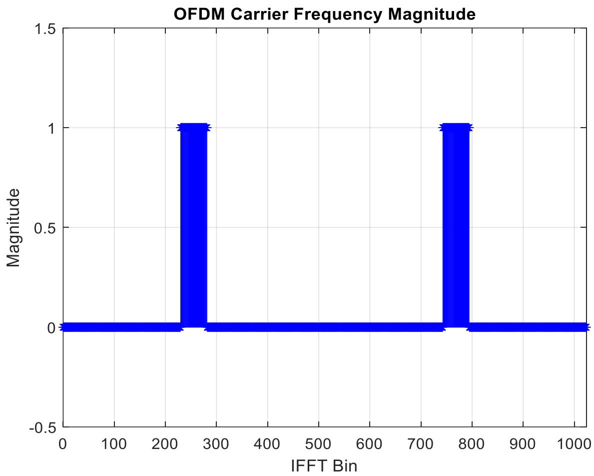

FIG 8: OFDM CARRIER FREQUENCY MAG

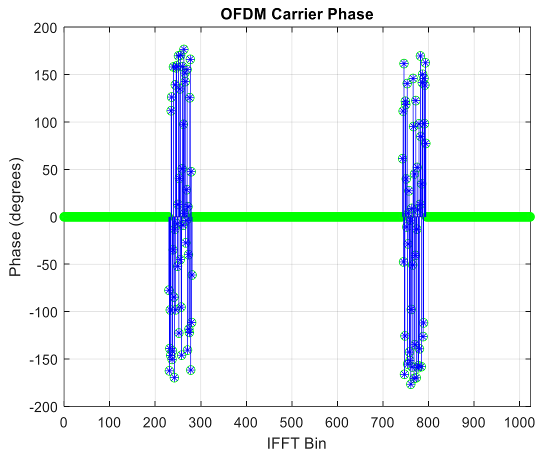

FIG 9: OFDM TIME SIGNAL

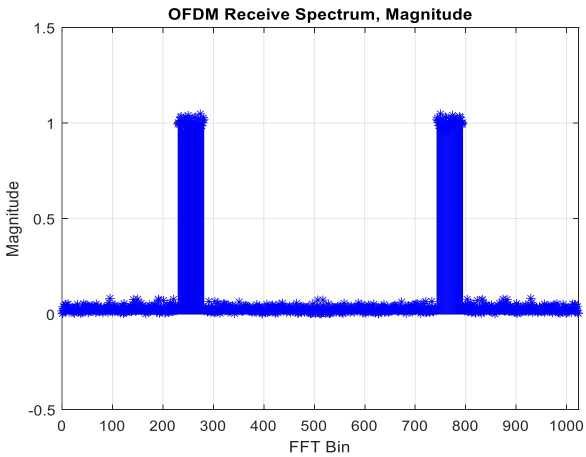

FIG 10: OFDM RECEIVER SPECTRUM MAG

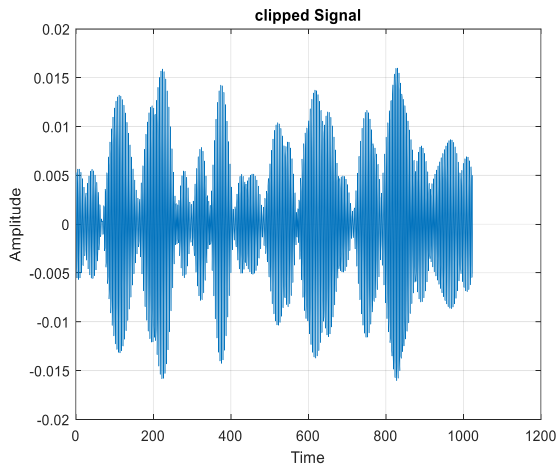

FIG 12: CLIPPED SIGNAL

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁑ Impact Factor 7.12 ⁑ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101007

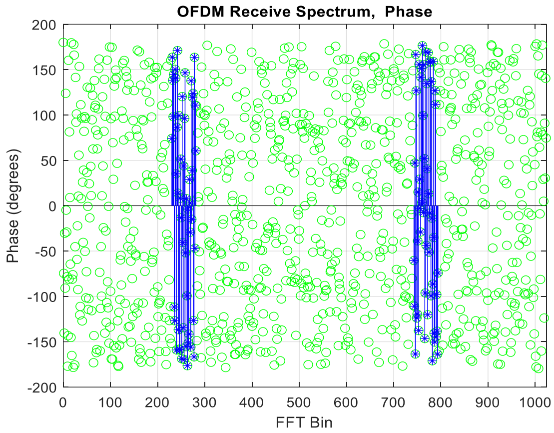

FIG 11: OFDM RECEIVER SPECTRUM PHASE

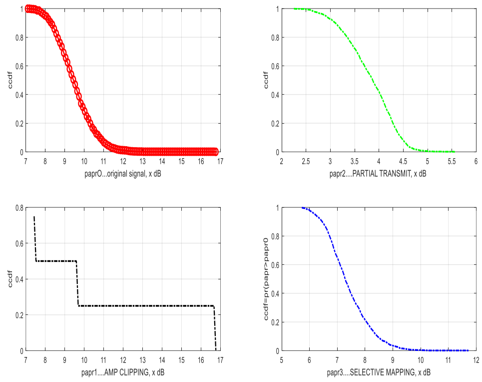

FIG 13: COMPARISION OF AMPLITUDE CLIPPING, PARTIAL TRANSMIT SEQUENCE TECHNIQUE, SELECTIVE MAPPING TECHNIQUE

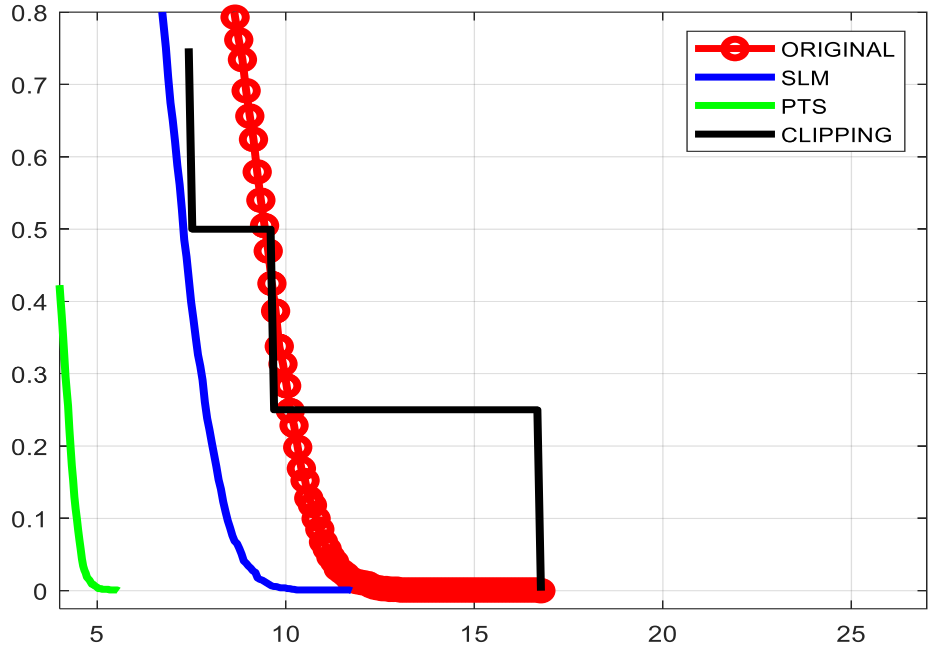

FIG 14: COMPARISION OF AMPLITUDE CLIPPING, PARTIAL TRANSMIT SEQUENCE TECHNIQUE, SELECTIVE MAPPING TECHNIQUE.

V. CONCLUSION

The PAPR problem is one of the concern to be addressed in developing multicarrier transmission systems in OFDM system. In order to minimize the effects of high PAPR in OFDM systems, clipping is a simple solution that results from this paper. Clipping is a non-linear operation that introduces inter modulation noise in the OFDM system. The performance of OFDM system can be improved by reducing the PAPR using clip and filter scheme.The OFDM system is implemented using Software Defined Radios.

DOI: 10.17148/IJIREEICE.2022.101007

REFERENCES

[1] Guibin Zhu, Changxiu Cao, Zhongyu Hu, Shibiao He, Sen Bai, ― Digital image scrambling encryption algorithm based on affine transformation[J]‖, Aided Design and Computer Graphics, Vol.15, No.6,2003, pp. 711-713.

[2] K.S.Thyagarajan, ―Still Image and Video Compression with MATLAB‖, A John Wiley & Sons, INC., Publication, 2011. ISBN: 978-0-470-48416-6.

[3] Jackson .J.D Hannah S.J, ―Comparative analysis of image compression techniques", System Theory, 1993, Proceedings SSST '93, Twenty-Fifth Southeastern Symposium on, pp.513-517, 7-9 Mar 1993. Available: http://dx.doi.org/10.1109/SSST.1993.522833

[4] Tellado, J.: Multicarrieer Modulation with Low PAR Applications to DSL and Wireless, Kluver Academic Publishers, 2000.

[5] R. van Nee and R. Prasad, "OFDM Wireless Multimedia Communications," Artech House, Boston, MA, 2000

[6] S. H. Han, J. H. Lee, "An Overview of Peak – to – Average Power Ratio Reduction Techniques for Multicarrier Transmission", IEEE Transaction on Wireless Communication, April 2005

[7] C.Vennila, SatyashilNagrale, G.Lakshminarayanan, "FPGA implementation of adaptive mode PAPR reduction for cognitive radio applications" in the proceedings of "(CSNT 2011), International Conference on Communication Systems and Network Technologies" Organized by IEEE, Katra, Jammu on May 2011.

[8] C.Vennila, PuneetHyanki, H. LakshmanSharma, G. Lakshminarayanan, Moon Ho Lee and S. Ko, "PAPR Reduction For Improving Performance Of OFDM Systems" in the proceedings of "(ICCCCT 2010) IEEE International Conference On Communication Control And Computing Technologies" Organized by Ieee Chapter, Nagarkoil, Tamilnadu on 7-9 Oct. 2010. **DOI:** 10.1109/ICCCCT.2010.5670530

[9] Sandeep Bhad, Pankaj Gulhane, A.S. Hiwale, PAPR Reduction Scheme for OFDM,Procedia Technology, Volume 4, 2012,Pages 109-113, ISSN 2212-0173, https://doi.org/10.1016/j.protcy.2012.05.015.

BIOGRAPHY

Ubendran.V is an undergraduate student pursuing bachelor degree in Electronics and communication Engineering in Saranathan College of Engineering Trichy. He has completed four NPTEL courses. He was a member of NCC and received an NCC A certificate from the Goverment of India. His areas of interests are Digital Signal Processing , Dgital Electronics and VLSI.

Mohan V is an Associate Professor in Saranathan College of Engineering, Tiruchirapplaii, TamilNadu. He completed his bachelor's degree Electronics and Communication Engineering from Bharathidasan University in the year of 1998. He obtained his masters in Communication Systems from Madurai Kamarajar University in the year 2001. Also, he has obtained PhD from Anna University Chenani in the year 2015. He has more than 21 years of experience in teaching. His areas of research include image processing, image compression, machine learning, IoT, and RF and Microwave engineering. Under his guidance, two research scholars are pursuing research works.

Dr.M.SANTHI has received her B.E. degree in Electronics and Communication Engineering in 1990 in Bharathidhasan University. She has received her M.E. degree in VLSI Systems in REC (Currently NIT) Trichy in 2003. She has received her Ph.D. degree in VLSI Systems in NIT, Trichy in 2013. She is having more than 27 years of teaching experience. She is Member of Board of Studies (BoS) in Anna University, Chennai during 2016-2019 for UG and Syllabus sub-committee member and coordinator for framing the R2021 syllabus for 2 PG programmes. She is a PAC Committee Member in SIT, Trichy in 2017. She is a recognized supervisor of Anna University, Chennai. Five research scholars were awarded Ph.D., one research scholar has submitted Synopsis and 3 research scholars are pursuing Ph.D under her guidance. She published more than 65 papers in reputed National and International Journals and Conferences such as Elsevier, Springer, Taylor & Francis, IETE Journal of Research and IEEE and Springer Conferences. She published a book chapter in Springer. She is a reviewer of reputed journals such as Springer CSSP, IEEE Access, Journal of Textiles research etc. She received a grant of Rs.21,51,046/- from AICTE under RPS scheme, a grant of Rs.12.0 Lakhs from AICTE under MODROBS scheme and a travel grant of Rs.20,000 from DST to present a paper in International Conference in Singapore in 2009. She received **"Best Teacher Award"** from Saranathan College of Engineering in 2006. She is a

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
ISO 3297:2007 Certified ⪤ Impact Factor 7.12 ⪤ Vol. 10, Issue 10, October 2022
DOI: 10.17148/IJIREEICE.2022.101007

Life Member of Indian Society of Systems for Science and Engineering (ISSE). Her area of interest includes VLSI Systems, Asynchronous Techniques, Wave Pipelining, Wireless Communication PHY Layer Implementation, NoC, Nanotechnology, Image processing, Pattern Recognition, Deep Learning Network, Embedded Systems and Antenna Design.