*Impact Factor (SJIF): 3.632*

**International Journal of Advance Research in Engineering, Science & Technology**

*e-ISSN: 2393-9877, p-ISSN: 2394-2444*

***Volume 3, Issue 12, December-2016***

# IMPACT OF CLIPPING NOISE ON OPTICAL WIRELESS COMMUNICATION SYSTEMS BY USING OFDM

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***Abstract — Orthogonal Frequency Division Multiplexing (OFDM) is important multiplexing technique in optical communications because of its robustness against channel dispersion and its high spectral efficiency. Orthogonal Frequency Division Multiplexing (OFDM) is a way to overlap multiple channel spectra with limited bandwidth without interference taking considerations of effect of both filter and channel characteristics. Clipping results from imperfect biasing and non linarites at transmitter front end. With the optimal choice of modulation scheme, variation in system parameters depending upon operating conditions spectrum efficiency, energy efficiency and proper BER can be obtained. Here impact of clipping noise on optical wireless communication based on OFDM is discussed. The paper presents impact of clipping noise in optical wireless communication systems OFDM. The simulation results are presented to compare the bit error rate (BER) performance of Asymmetrically clipped optical OFDM (ACO - OFDM)and direct current bias optical OFDM( DCO-OFDM).***

***Keywords- Bit error rate, Clipping Noise, Orthogonal frequency Division Multiplexing.***

## I. INTRODUCTION

The ever increasing demand for very high-rate wireless data transmission calls for technologies which make use of the available electromagnetic resource in the most intelligent way. Key objectives are spectrum efficiency means bits per second per hertz, robustness against multipath propagation, range, power consumption, and implementation complexity. Two most effective means of closing the gap between the achieved performance and the channel capacity are advanced channel coding to combat noise and OFDM to combat multipath. OFDM (Orthogonal Frequency Division Multiplexing)allows data transition on orthogonal carriers [1, 4].

## II. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

OFDM is a special class of the Multi-Carrier Modulation (MCM) scheme that transmits a high speed data stream by dividing it into a number of orthogonal channels, referred to as subcarriers, each carrying a relatively-low data rate. Compared to WDM systems, where a fixed channel spacing between the wavelengths is usually needed to eliminate crosstalk, OFDM allows the spectrum of individual subcarriers to overlap because of its orthogonality, as depicted in Figure1 [13].Furthermore, the inter-symbol interference (ISI) of the OFDM signal can be mitigated as the per-subcarrier symbol duration is significantly longer than that of a single-carrier system of the same total data rate.

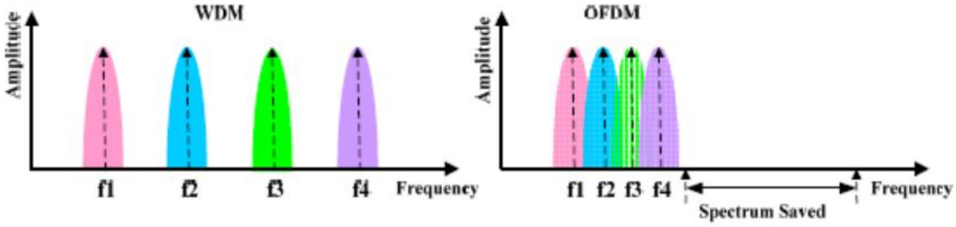


***Figure 1: Spectrum of WDM signals and OFDM signals***

OFDM modulation and demodulation can be implemented using inverse discrete Fourier transform (IDFT) and discrete Fourier transform (DFT), respectively. The discrete value of the transmitted OFDM signal s(t) is a N-point IDFT of the information symbol ck, and the received information symbol c'k is a N-point DFT of the received sampled signal r(t). To reduce the computational complexity of DFT/IDFT, efficient fast Fourier transform and inverse fast Fourier transform (FFT/IFFT) functions are normally used in OFDM systems to implement OFDM modulation and demodulation [13,14].

A generic building block diagram of an OFDM system is shown in Figure 2 and Figure 3 At the transmitter end, the input serial data stream is first converted into many parallel data streams through a serial-to parallel (S/P) converter, each mapped onto corresponding information symbols for the subcarriers within one OFDM symbol. Then, training symbols (TSs) are inserted periodically for channel estimation. These parallel data streams are modulated onto orthogonal subcarriers and converted to the time-domain OFDM signal, which is a two-dimensional complex signal including real and imaginary components, by applying the IFFT.

Subsequently, a cyclic prefix is added into each OFDM symbol to avoid channel dispersion. The OFDM signal is then converted to analog by digital-to-analog conversion (DAC), and filtered with a low-pass filter (LPF) to remove the alias signal, yielding the OFDM baseband signal. The baseband signal can be up-converted to an appropriate radio frequency (RF) pass band with an in-phase or quadrature-phase (IQ) modulator and a band-pass filter (BPF).

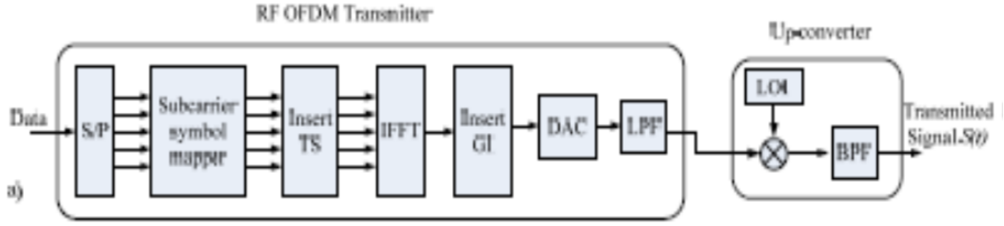


***Figure 2: OFDM Transmitter***

At the receiver end, the OFDM signal is down-converted to baseband with an IQ demodulator, sampled with an analog-to-digital converter (ADC), and then the complex-form OFDM signal is demodulated by a fast Fourier transform (FFT) function. The demodulated signals go through a symbol decision module, where synchronization, channel estimation, and compensation are performed before a symbol decision is made. Finally, multiple data channels are converted back to a single data stream by parallel-to-serial (P/S) operation [10, 11].

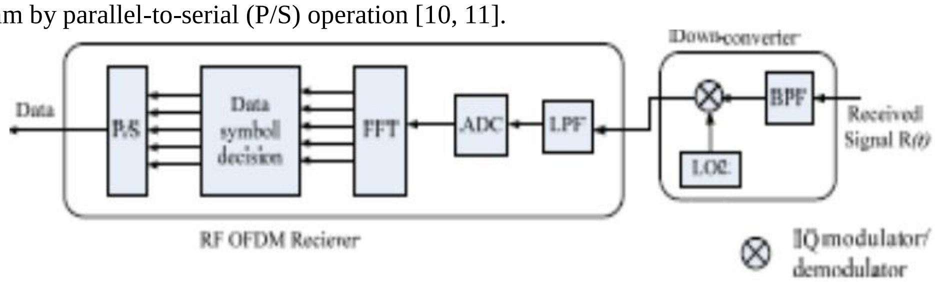


***Figure 3: OFDM Receiver***

## III. SCHEMATIC MODEL

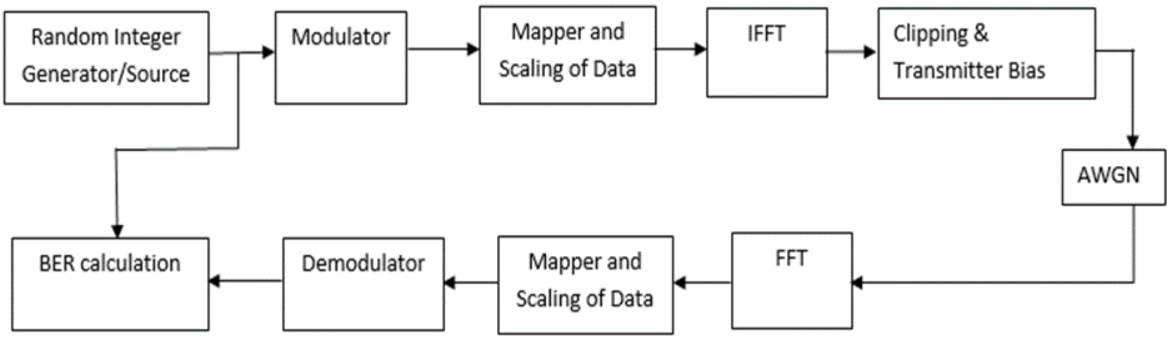


***Figure 4: Schematic model***

This schematic model is the general setup for an optical communication system. The transmitter section consists of a source, mapper, random integer generator i.e. data source and modulator. Then all these transmitted signals are combined/multiplexed together using OFDM system. Then the combined signal is passed which gets affected with Additive White Gaussian Noise (AWGN).Then at the receiver side, the signal is demultiplexed. The receiver consists of frame converter, equalizer, mapper and demodulator. Bit Error Rate calculation is done by error rate calculator for different modulation.

The scaling is called as pre clipping which shrinks the data according to the biasing constraints. This data is passed towards receiver. During transmission data gets affected by AWGN. Effect of AWGN will be comparatively less in OFDM. At receiver side data is retrieved in original format by using FFT based approach, demapping and demodulation. Further bit error rate (BER) is calculated and two schemes ACO-OFDM and DCO-OFDM are compared [2, 1, 6].

## IV. SIMULATION AND DESCRIPTION

The proposed work can be examined with the help of various softwares. The accuracy of the analysis of the double-sided signal clipping distortion in O-OFDM is verified by means of a Monte Carlo BER simulation in MATLAB. In ACO BER is disturbed but spectrum efficiency increases.

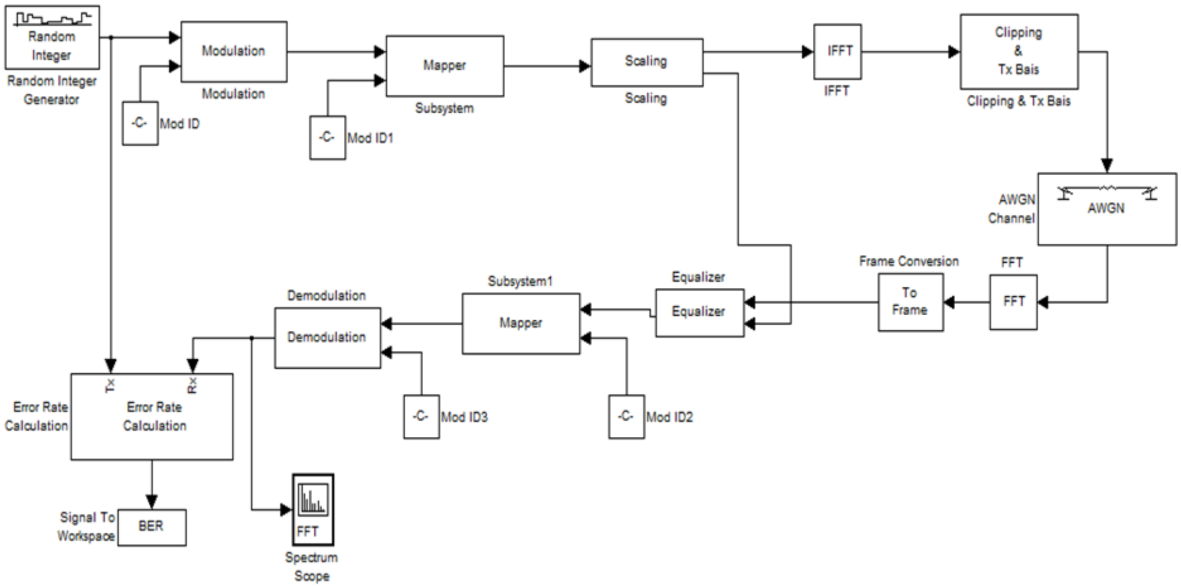


*Figure 5: Block Diagram of the OFDM-Based OWC System*

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Here the OFDM-based OWC (Optical Wireless Communication) system is verified for BER performance and spectrum efficiency for optical transmission systems ACO and DCO. From both these graphs, it is concluded that for 4 QAM ACO & DCO, BER is high in ACO as compared to DCO and spectrum efficiency is less. But from next graph it is concluded that for 16 QAM ACO & DCO, DCO is having better BER and spectrum efficiency than ACO. There is reduction in spectral efficiency of ACO for 16QAM.

| Parameters | ACO | DCO |
|---|---|---|
| Spectrum Efficiency(Channel Capacity) | Less | More |
| Error Rate | Acceptable | Not acceptable |
| Spectrum Efficiency | Good (Less than DCO) | Better |

*Table 1: Comparison of Modulation Techniques*

## V. RESULTS AND DISCUSSION

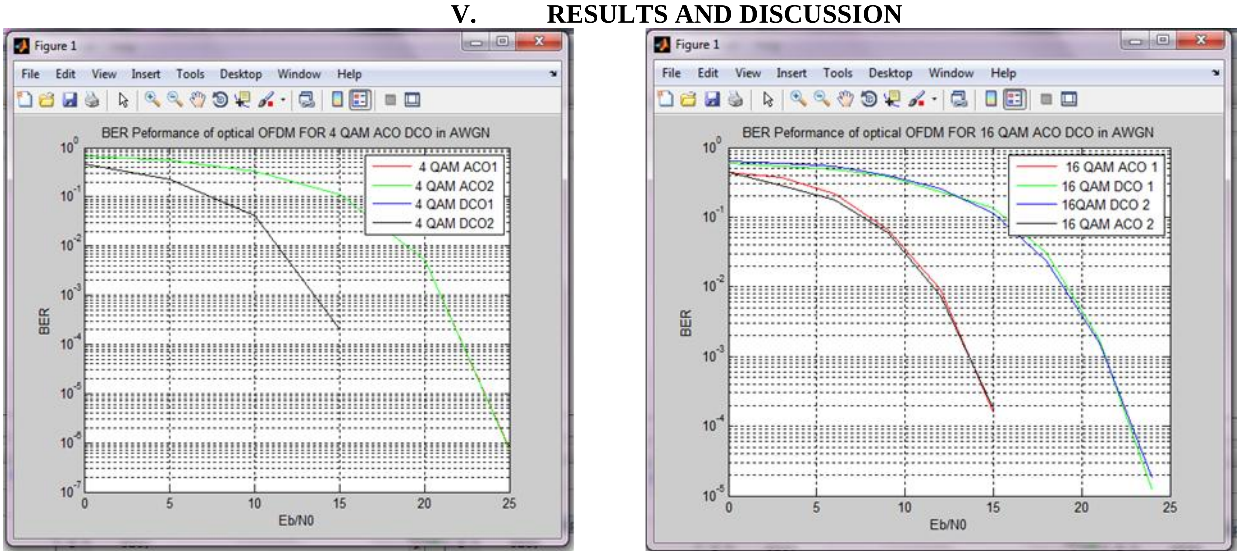


*Figure 6: Comparison of ACO-OFDM and DCO-OFDM for 4QAM and 16 QAM*

The above graphs are showing BER performance of optical transmission schemes, asymmetrically clipped optical OFDM (ACO-OFDM) and direct current bias optical OFDM (DCO-OFDM).

Here the OFDM-based OWC (Optical Wireless Communication) system is verified for BER performance and spectrum efficiency for optical transmission systems ACO and DCO. From both these graphs, it is concluded that for 4 QAM ACO & DCO, BER is high in ACO as compared to DCO and spectrum efficiency is less. But from next graph it is concluded that for 16 QAM ACO & DCO, DCO is having better BER and spectrum efficiency than ACO. There is reduction in spectral efficiency of ACO for 16QAM.

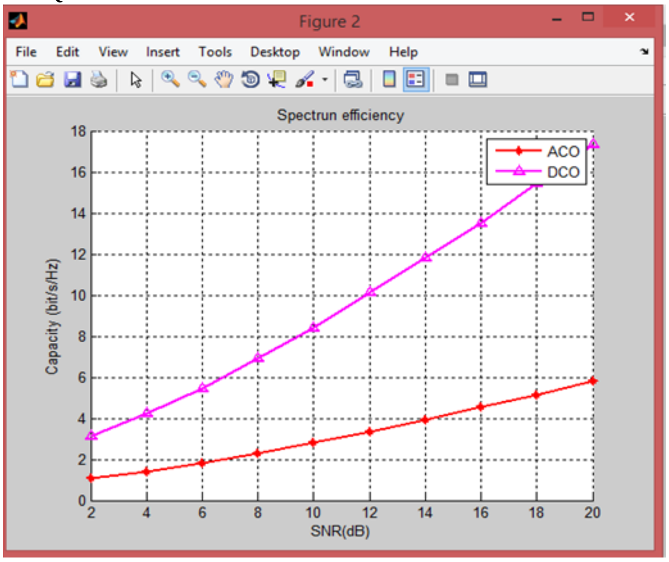


***Figure 7: Graph of Spectrum Efficiency***

Where on Y axis Channel capacity (bit/Hz) on X axis SNR (dB)

## VI. CONCLUSION

In this paper, the design, implementation and performance analysis of clipping noise in optical wireless communication system based on OFDM is presented. The comparison of optical modulation schemes ACO-OFDM and DCO-OFDM in optical wireless communication system is carried out. It is found that DCO-OFDM has the better BER performance and spectrum efficiency than ACO-OFDM.

Hence, OFDM has long been studied and implemented to combat transmission channel impairments. Its application have been extended from high frequency radio communications to telephone networks, digital audio broadcasting and terrestrial broadcasting of digital television. The advantages of OFDM, especially in the multipath propagation, interference and fading environment, make it promising technology in mobile communication.

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