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IMPLEMENTATION OF OFDM IN XILINX VIVADO SOFTWARE

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Abstract- A fast Fourier transform (FFT) is an algorithm to compute discrete Fourier transform. A Fourier transform convert's time domain signal information into frequency domain.This paper proposed to use efficient multiplication technique to reduce the partial product which is happened in conventional multiplication technique therefore the FFT and inverse fast Fourier transform (IFFT) with efficient multiplication and with increased speed is used for Orthogonal Frequency Division Multiplexing (OFDM) Modulator and Demodulator blocks. In many applications high speed and efficient multiplication is desired. For this purpose conventional multicarrier technique are usually chosen, but this results in lower spectrum efficiency. So, the principles of OFDM are used. This proposed work will be processing block of an OFDM system, which are applied to FFT and IFFT. Actually, in entire architecture all the mathematical manipulation takes place in transmitter and receiver block i.e. IFFT and FFT block respectively. The speed enhancement is the key contribution of the main processing blocks in OFDM system.

Keywords: OFDM, FFT, IFFT.

Introduction:

The main reason to use OFDM is to increase the robustness against the selective fading or narrowband interference. In single carrier system if signal get fade or interfered then entire link gets failed where as in multicarrier system only a small percentage of the subcarriers will be affected. The total signal bandwidth, in a classical

parallel data system, can be divided into N non-overlapping frequency subchannels. Each sub-channel is modulated a separate symbol and then N sub-channels are frequency multiplexed. The general practice of avoiding spectral overlap of sub-channels was applied to eliminate intercarrier OFDM is a combination of modulation and multiplexing. Multiplexing generally refers to independent signals, those produced by different sources. In OFDM the signal itself is first split into independent channels, modulated by data and then remultiplexed to create the OFDM carrier. OFDM is a special case of Frequency Division Multiplex (FDM).

Orthogonal frequency division multiplexing (OFDM) has recently become a key modulation technique for both broadband wireless and wire-line applications. It has been adopted for digital audio broadcasting (DAB) and digital terrestrial television broadcasting (DVB). OFDM is a special case of Multicarrier transmission, where a single data stream is transmitted over number of lower rate Subcarrier. The problem of inter symbol interference (ISI) introduced by multipath channel is significantly reduced in OFDM by using the cyclic prefix (CP) as a guard interval between OFDM blocks. The proposed work would be a brief overview of IFFT & FFT algorithm to be effectively used in OFDM system. OFDM is a special case of multicarrier transmission, where a single data stream is transmitted over a number of lower rate subcarriers.

Literature Survey:

Vishal Digambar Bodkhe has proposed a MIMO OFDM LTE system based on a parallel IFFT/FFT on NoC based FPGA. In which implement the parallelization of IFFT, change parameters in NoC.

Ming chen, Xin Xiao, This paper presented the 32-point FFT and IFFT design for OFDM. And also run the verilog code in implementation of OFDM system using FFT and IFFT.

Kais Jallouli, Mohamed mazouzi, In this paper, DFT spread orthogonal frequency division multiplexing based on complex valued IFFT and FFT operations without Hermitian symmetry constraints.

Bing Yang, Anping jiang, has proposed a VLSI Implementation of Fast fourier transformation for OFDM based high speed wireless applications, design about the DIT radix-2 butterfly FFT algorithm.

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Existing Method:

Orthogonality is a property that allows multiple information signals to be transmitted perfectly over a common channel, thereby making better spectrum utilization. The signal is detected without interference. Ultimately ISI is conquered. Loss of orthogonality results in blurring between the information signals and degradations in communications. Two periodic signals are orthogonal when the integral of their product, over one period, is equal to zero and they have integral number of cycles in the fundamental period. Orthogonality of subcarriers is crucial for OFDM system. If orthogonality is destroyed, the receiver will have a serious bit error rate due to (ICI). A cyclic extension of the signal in time domain called cyclic prefix (CP) is inserted between each OFDM symbol to eliminate ISI almost completely for it is larger than maximum of time delay, which keeps orthogonality between each subcarriers as well.

The proposed design has been presented in this section. Figure 1 shows the diagram of proposed OFDM design. Radix-2 serialized FFT algorithm is used. The FFT block implements the Decimation-inTime (DIT) FFT algorithm. It is composed of 9 stages of radix-2 butterfly units. These FFT stages are pipelined which further enhances its speed and is simulated up to 227.355 MHZ frequency. A serial FFT implemented in this model uses only one butterfly resource for each stage of implementation. With help of this area factor is also taken care of. Hence there is an optimized design in terms of both speed and area.

Proposed Design:

The aim is to design an OFDM transmitter and receiver using FPGA. At the transmitter end, the OFDM signal is generated by implementing the IFFT. At the receiver end, the FFT is implemented.. Fig. 4 Implementation of Digital OFDM The objective is to use High-Speed-Integrated-Circuit to produce VHDL codes that carry out FFT and IFFT function.

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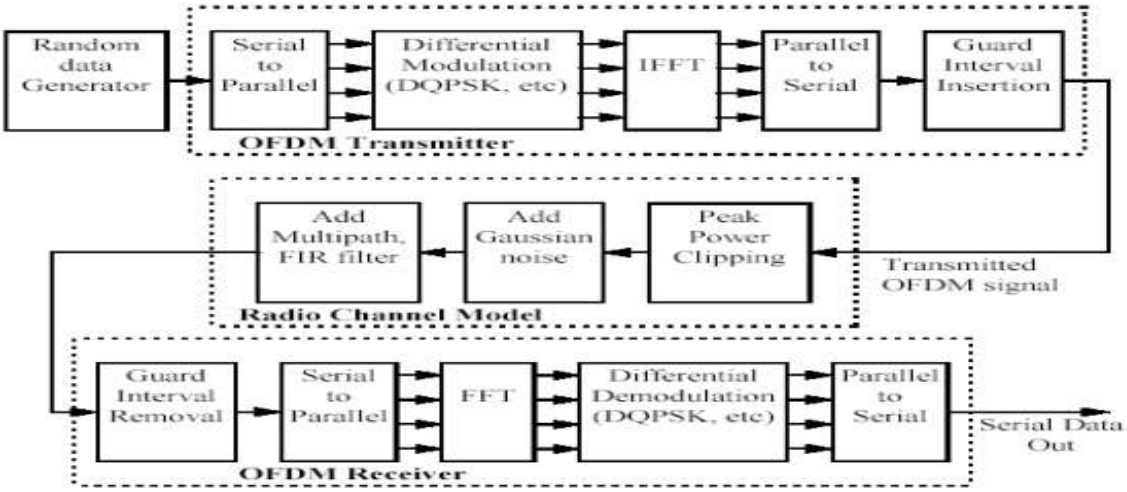

Fig: Internal Block diagram of OFDM

The fast Fourier transform (FFT) and inverse fast Fourier transform (IFFT) are derived from the main function, which is called discrete Fourier transform (DFT). In DFT, the computation for N-points of the DFT will be calculated one by one for each point. While for FFT/IFFT, the computation is done simultaneously and this method saves quite a lot of time.the FFT computation is accomplished in five stages. The X(0) until X(31) variables are denoted as the input values for FFT computation and Y(0) until Y(31) are denoted as the outputs. There are two operations to complete the computation in each stage. The upward arrow will execute addition operation while downward arrow will execute subtraction operation. The subtracted value is multiplied with twiddle factor value before being processed into the next stage. This operation is done concurrently and is known as butterfly process.

The main focus is the FFT and IFFT part of the OFDM system. The input symbols are fed to the transmitter in series at R symbols/second. These symbols pass through a serial to parallel converter and output data on M lines in parallel. The M symbols are sent to an IFFT block that performs N point IFFT operation. The IFFT transform a spectrum (amplitude and phase of each component) into a time domain signal. An IFFT converts a number of complex data points, of length that is power of 2, into the same number of points in time domain.

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SimulationResults:

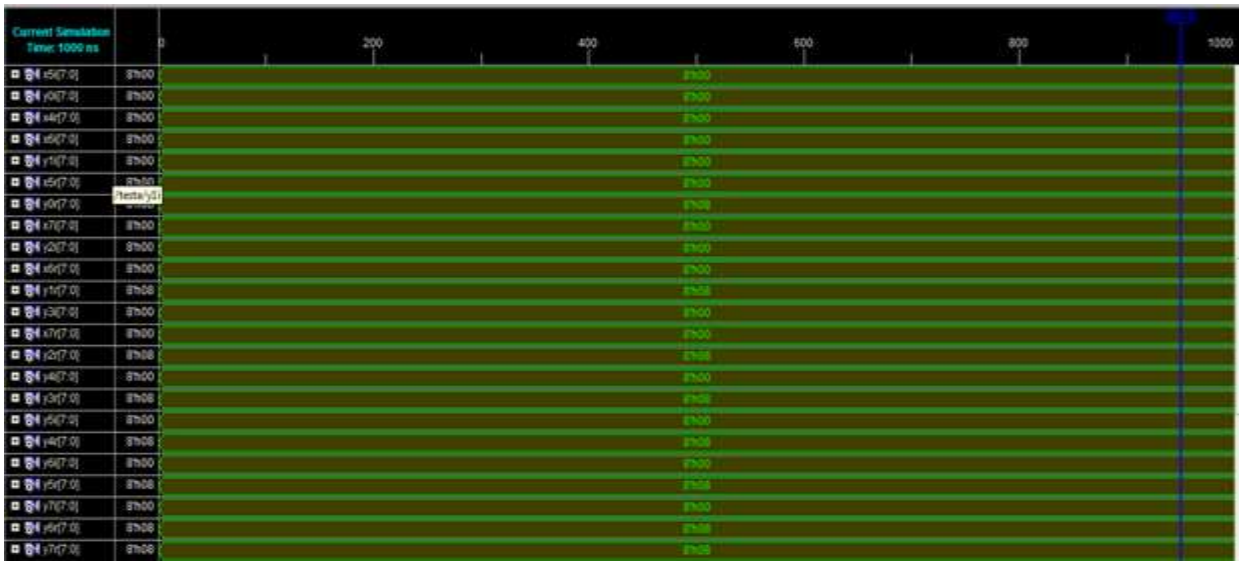

Fig: Simulated Result of OFDM Transmitter

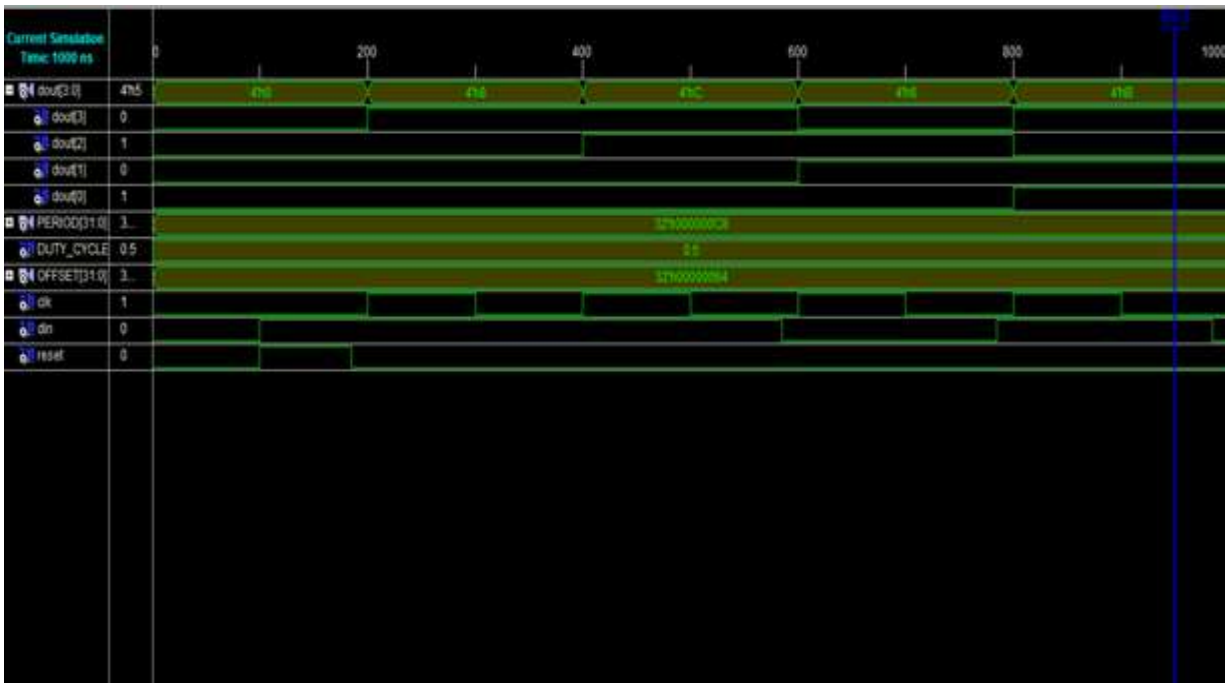

Fig: Simulated result for Serial to parallel Converter

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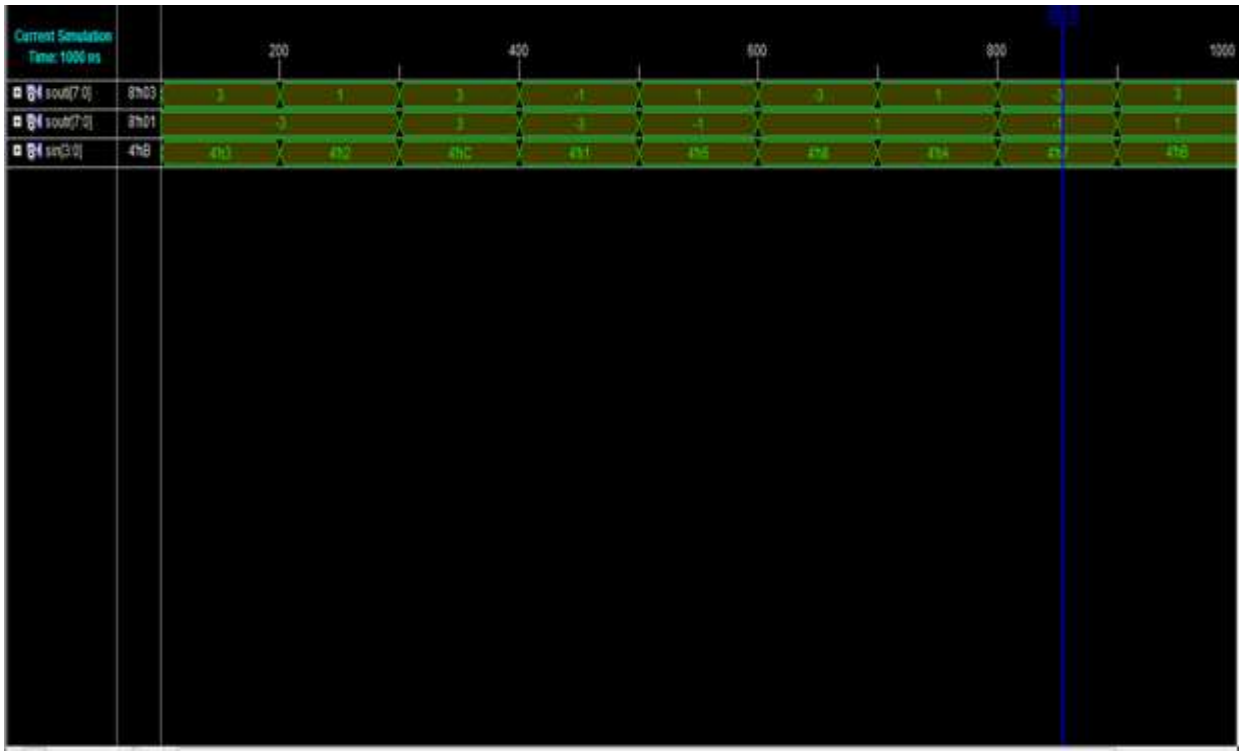

Fig: Simulated Result for QAM Modulator

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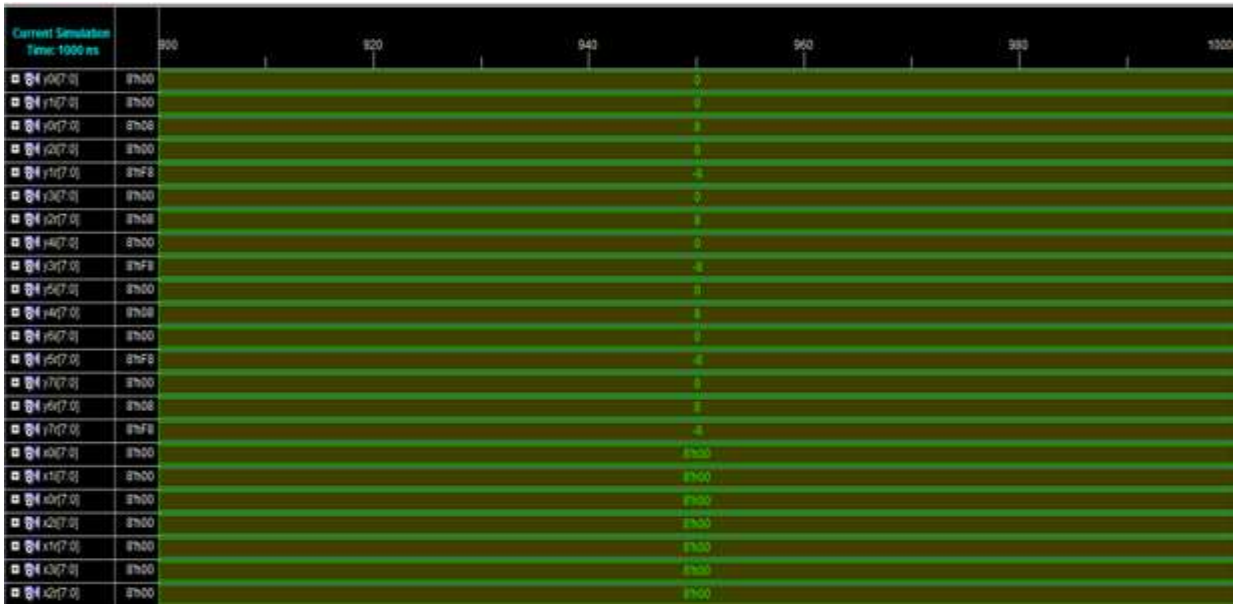

Fig: Simulated result of Radix-2 8 point IFFT

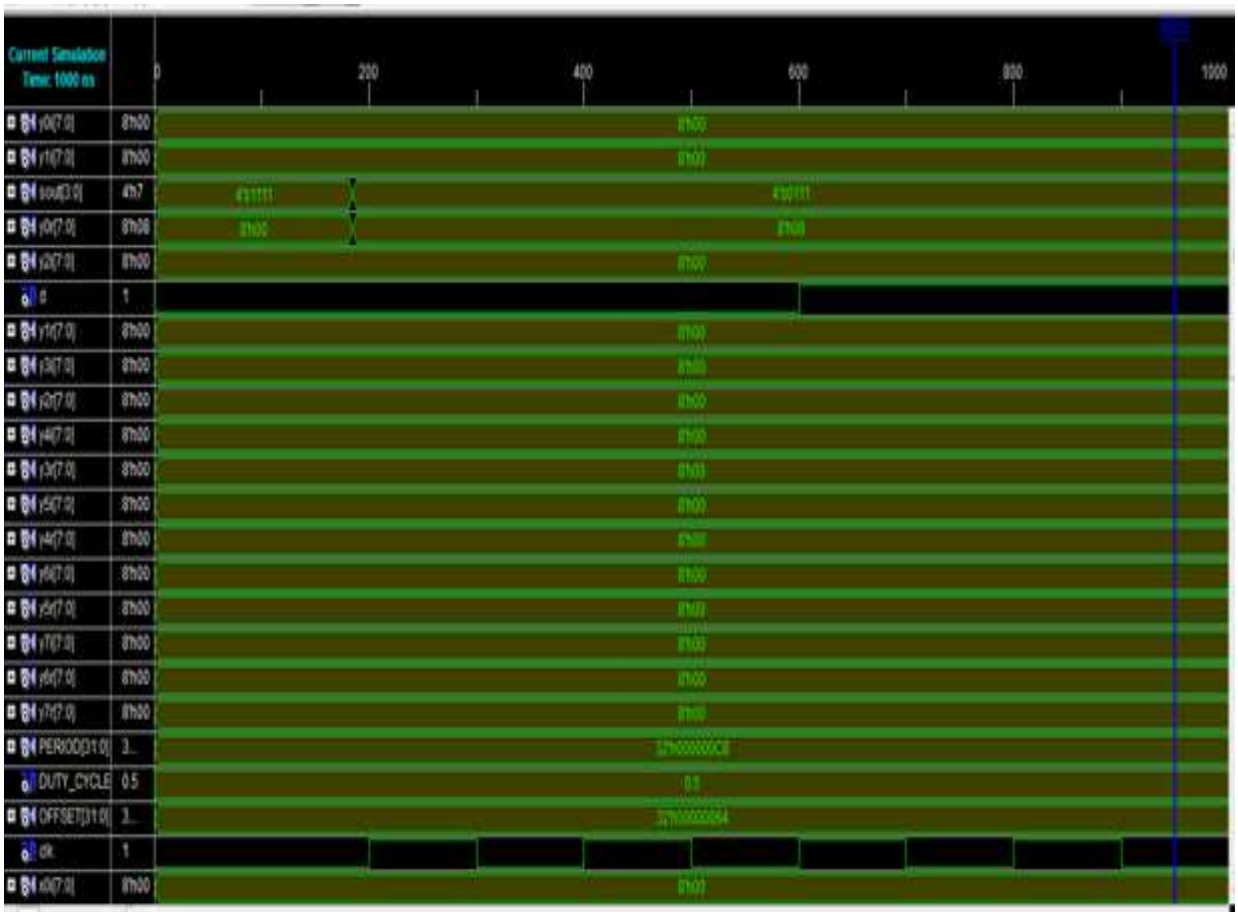

Fig: Simulated for OFDM Receiver

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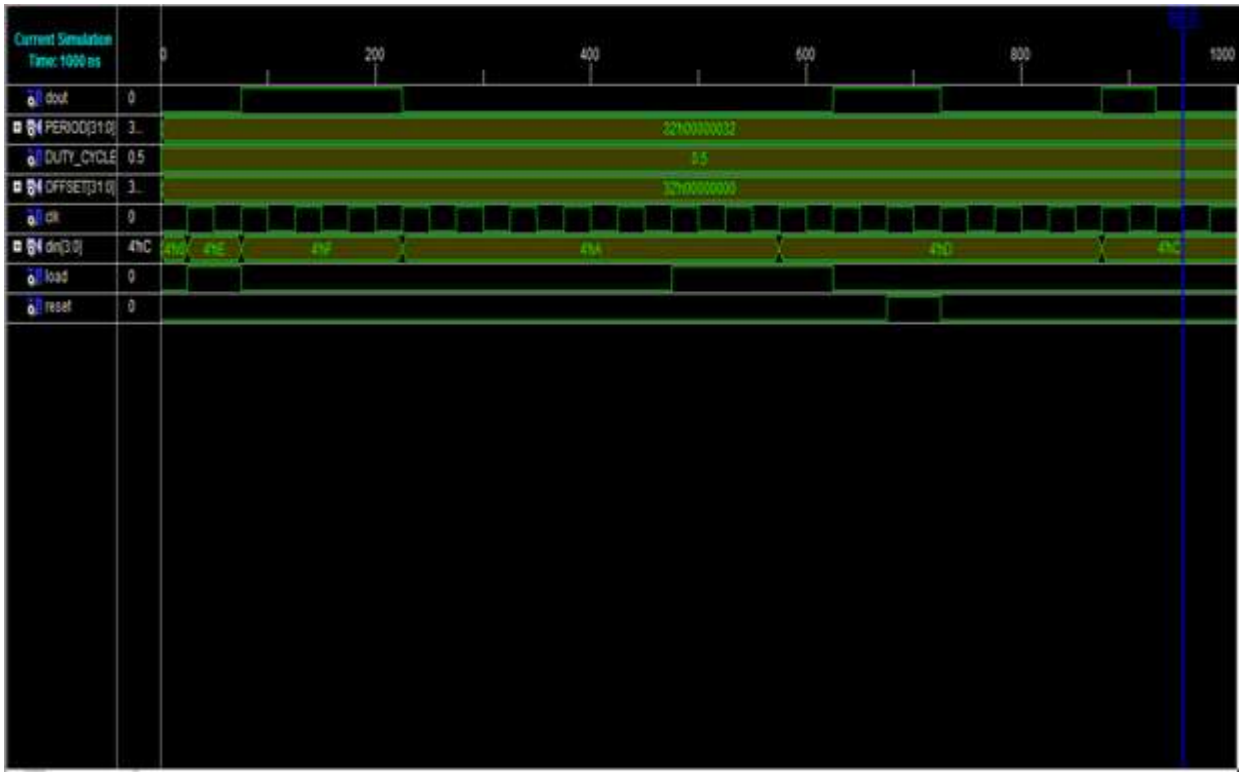

Fig: Simulated Result for Parallel in Serial out shift register

Conclusion:

The main aim of the project is to implement the core signal processing blocks of OFDM system using Verilog HDL language. The different blocks of OFDM system such as QAM Modulator, 8-IFFT, 8-FFT and Demodulator is designed on Xilinx project navigator. By using these blocks the size of circuit is reduced by supplementing multipliers and summers by an FFT and an IFFT block. OFDM implementation results in optimal usage of bandwidth and reduces multiple paths and thus reducing inter-symbol interference. OFDM is the most emerging technology being used in DVB, ADSL Modems, Digital video broadcasting. These blocks are simulated on VIVADO Design Suite, tested for different data patterns and results are compared with theoretical expected results and found to be same.

In future work case, OFDM system is simulated using 8 subcarriers i.e. with 8 point IFFT and FFT. This is very basic implementation and has advantage of less processing time requirement and complexity but this system has less spectral efficiency. The spectral efficiency can be increased by increasing the number of subcarriers i.e. by using 64 point IFFT and FFT. ADSL Modems, DVB and Digital video broadcasting use OFDM. All modern digital communication systems are in the way of using OFDM for bandwidth efficiency and spectral efficiency.

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