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PERFORMANCE ANALYSIS OF PV SYSTEMS USING SINGLE AND PARALLEL H5 INVERTER WITH SINGLE CHOPPER

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Abstract:

Nowadays renewable resources play a viable role in power generation to reduce the demand of the end users. The generated power is to be transmitted and distributed to the end user with power quality and cost effectiveness. To enhance the efficiency of the power generated from photo voltaic system, total harmonic distortion is reduced using chopper and H5 inverter. In the proposed method, the usage of choppers is less while Scomparing with existing method. Hence the cost can be reduced significantly. In this paper, an analysis is done on single chopper single inverter (SCSI) and single chopper parallel inverter (SCPI) based on Total Harmonic Distortion (THD). The Total Harmonic Distortion estimation is calculated using Pulse Width Modulation (PWM) technique for both the methods. The total harmonic distortion value for single chopper single inverter is 9.87% and for single chopper parallel inverter is 14.92%. Therefore single chopper single inverter has low harmonics while comparing with single chopper parallel inverter. Therefore Single chopper single inverter has been preferred in most of the applications like Home appliances, transmission lines, etc. because of low Total harmonic distortion.

Key Words: H5 Inverter, Single Chopper Single Inverter (SCSI) & Single Chopper Parallel Inverter (SCPI)

1. Introduction:

Non-renewable resource is a resource that cannot be re-consume again. Non renewable resources are fossil fuels such as coal, natural gas, etc. It is not sustainable because it takes few millions of year to form again. It have lots of disadvantages such as, it affects the environmental factors while mining for coal and use of uranium causes health problems and abnormalities in functioning of heart, lungs for long years. The main problem is the usage of fossil fuel gets reduced day by day. Hence our next generation cannot able to use the fossil fuels. The initial cost and maintenance cost are also high for non-renewable resources. In order to overcome that renewable resources are considered. Renewable resources are the resources we get naturally from the environment. It is sustainable and re-consumed. Renewable resources considered are hydro, wind, solar, bio gas, etc. It is pollution free resources.

In this paper solar renewable source is considered. The power is generated with the help of solar photovoltaic (PV) panel. A photovoltaic panel consists of individual PV cells. It is made up of silicon material. PV is a method used to convert solar energy into direct current electricity. It is converted by using semiconducting material that exhibit the photovoltaic effect.

The light energy from the sun strike the solar panel, the electrons gets released from the atoms in the semiconductor material. The conductors are connected to the both positive and negative terminal to form an electric circuit and current will flow through the conductor. The generated power is transmitted with power quality and efficiently with lower harmonics. In this paper the chopper and inverter circuits are utilized.

The main objective of this paper is to improve the efficiency by reducing the total harmonic distortion using chopper and H5 inverter. The H5 inverter is a single phase full bridge inverter. This paper includes the following section given below, in section II, Transformer-less full bridge inverter in parallel operation are analyzed. In section III, Analysis of single and parallel H5 inverter with single chopper is proposed. In section IV, Performance analysis for both analyzes are presented. In section V, THD estimation graph are presented. In section VI, the paper is concluded.

2. Transformer-Less Full Bridge Inverter in Parallel Operation:

If the transformer is removed, the leakage current is produced. This is the main drawback of conventional single phase inverter. This leakage current leads to serious health problem. In order to solve the problem of leakage current, two solutions are proposed. One is the negative terminal of PV panel is connected with neutral line. And the other is to disconnect the inverter during freewheeling operation.

To reduce the leakage current and high circulating current H5 inverter and Highly Efficient and Reliable Inverter Concept (HERIC) are utilized. These inverters used to maintain the constant voltage. The parallel operated H5 inverter is given in Fig. 2. The modes of operation of H5 inverter is given below,

Mode 1: The parallel inverters operated in active mode and the switches S_{11}, S_{14} are turned ON.

Mode 2: The one inverter is operated in active mode and the other inverter is operated in freewheeling mode and the switches S_{12}, S_{13} are turned ON.

Mode 3: The parallel inverters are operated in freewheeling mode and the switches S_{11}, S_{14}, S_{21}, S_{24} and S_{25} are turned ON.

In this method considered that the photovoltaic panel is connected in individual place. Each chopper is connected to the individual photovoltaic panel. Hence the DC output of solar module is given to chopper, it converts fixed DC to variable DC. The chopper output is given to the parallel connected H5 inverter. In order to reduce the leakage current, the inverter is connected in parallel. In parallel circuit the current is divided and hence circulating currents are minimized. The H5 inverter is operated in unipolar PWM strategy. The inverter converts the DC input to AC output and finally it is given to the load.

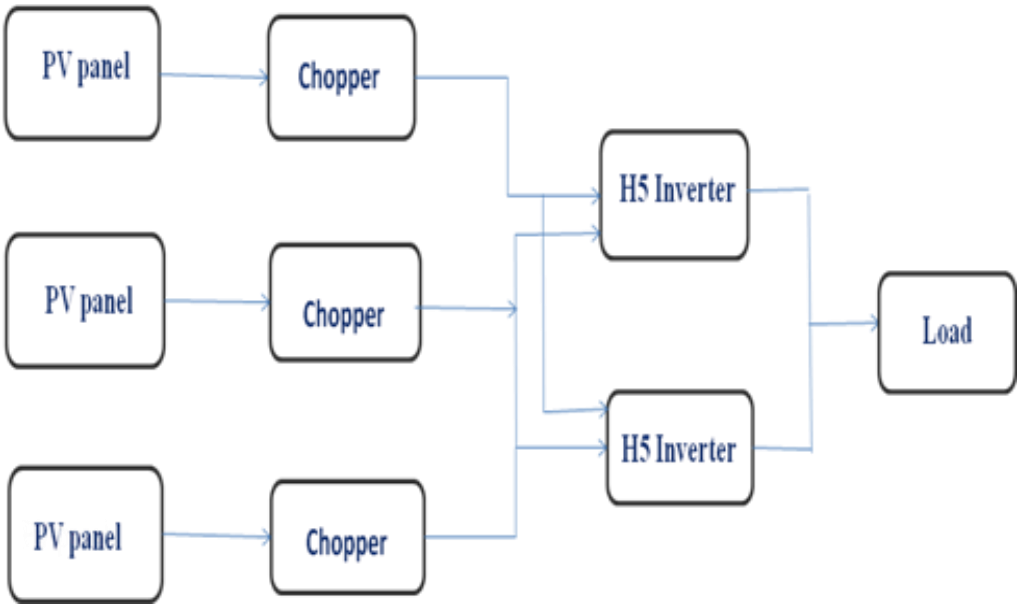

Figure 1: Block diagram for individual chopper and parallel H5 inverter

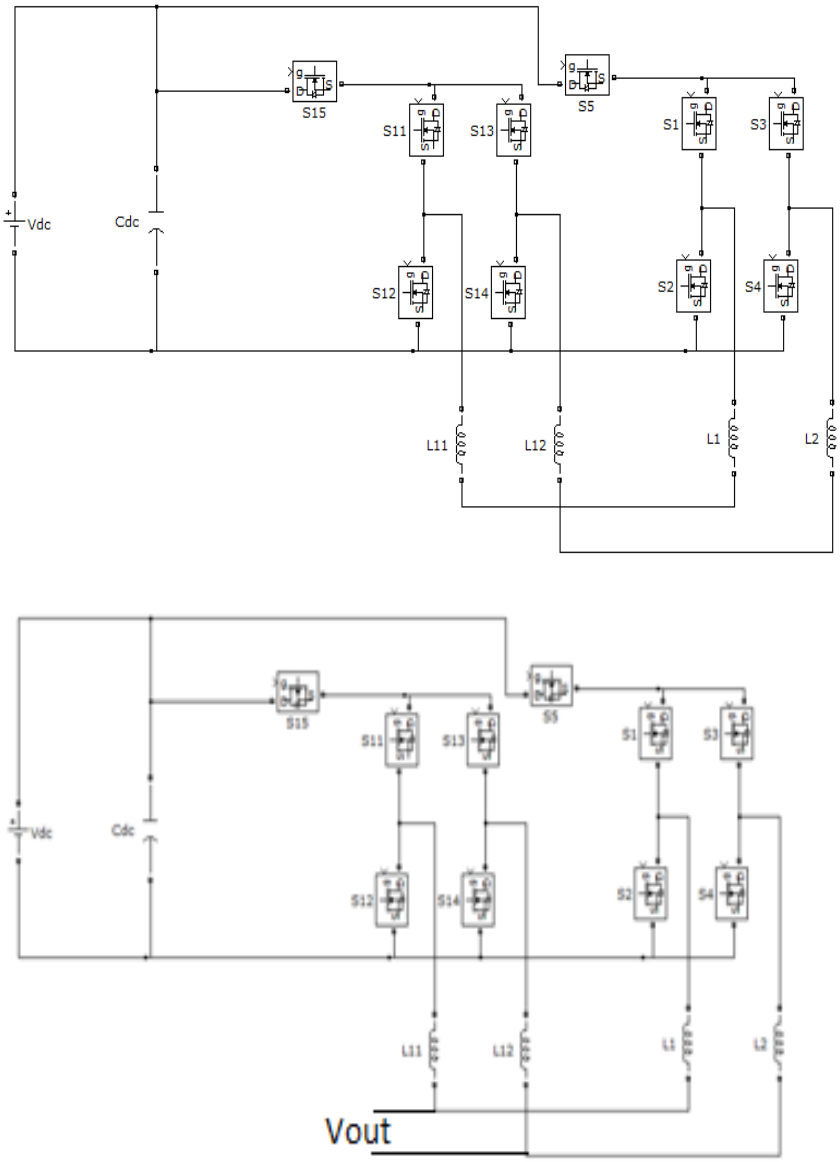

Figure 2: Circuit diagram for parallel operated H5 full bridge inverter

3. Analysis of Single and Parallel H5 Inverter With Single Chopper:

The major drawbacks of the existing system is the circuit is complex because of using number of choppers, cost is high and internal losses are also high due to usage of more circuit elements. The main objective of the paper is to reduce the complexity of circuit with single chopper- multiple input. Usage of single chopper instead of using multiple choppers. The leakage current analysis is made by two methods- single chopper single inverter (SCSI) and single chopper parallel inverter (SCPI). The analysis is made to improve the performance and reduction in leakage current. The inverters are controlled using PWM techniques.

Analysis I: Single Chopper Single Inverter:

In this analysis, the number of individual photovoltaic module is connected to single chopper with multiple input and single output. The solar energy is converted into DC in the panel and it is given to the chopper where the fixed DC input is converted into variable DC. The single chopper is connected to single H5 inverter. The DC output is

converted into AC by using the H5 inverter. By using the filter circuits in the load side, the harmonics gets reduced.

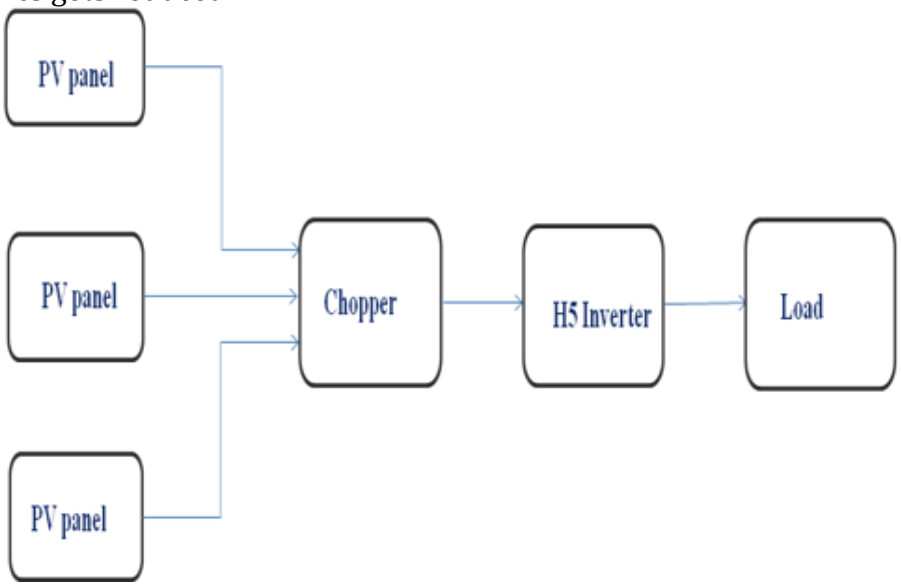

Figure 3: Block diagram for single chopper single H5 inverter

The operating modes of single chopper single inverter based on Fig. 4 is given below, the current will flow in the circuit only when the switch S_5 is always turned ON.

Mode 1: For positive cycle, the switches S_1 andS_4 are turned ON.s

Mode 2: For negative cycle, the switches S_2 and S_3 are turned ON.

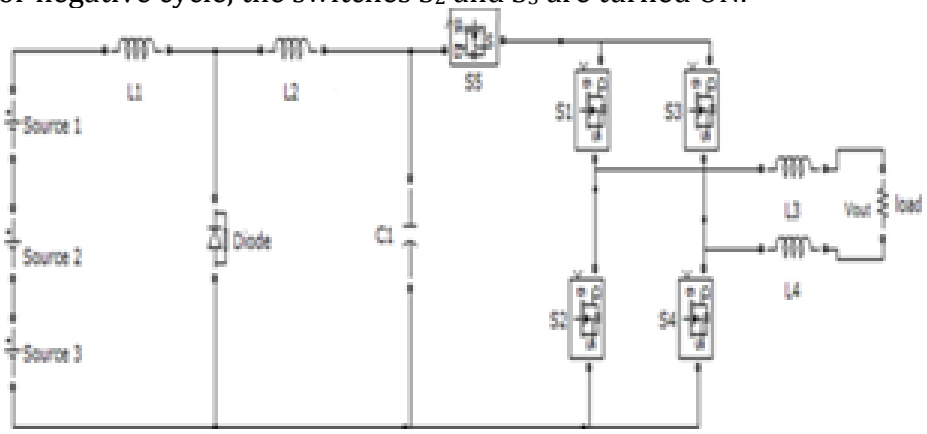

Figure 4: Circuit diagram for single chopper single H5 inverter

Analysis II: Single Chopper Parallel Inverter:

In this analysis, the photovoltaic module is connected to single chopper with multiple input and single output. The DC output of the panel is given to the chopper where the fixed DC input is converted into variable DC. The single chopper is connected to parallel H5 inverter. The DC output is converted into AC by using the H5 inverter. By using the filter circuits in the load side, the harmonics gets reduced. The leakage current and circulating currents are eliminated by using parallel H5 inverter. The operating modes of single chopper parallel inverter (Fig. 6) is given below, the switches S_{10}, S_{15} are always turned ON then only the current will flow through the circuit and switches are conduct.

Mode 1: For positive cycle, the switches S_6, S_9, S_{11}, and S_{14} are turned ON.

Mode 2: For negative cycle, the switches S_7, S_8, S_{12}, and S_{13} are turned ON.

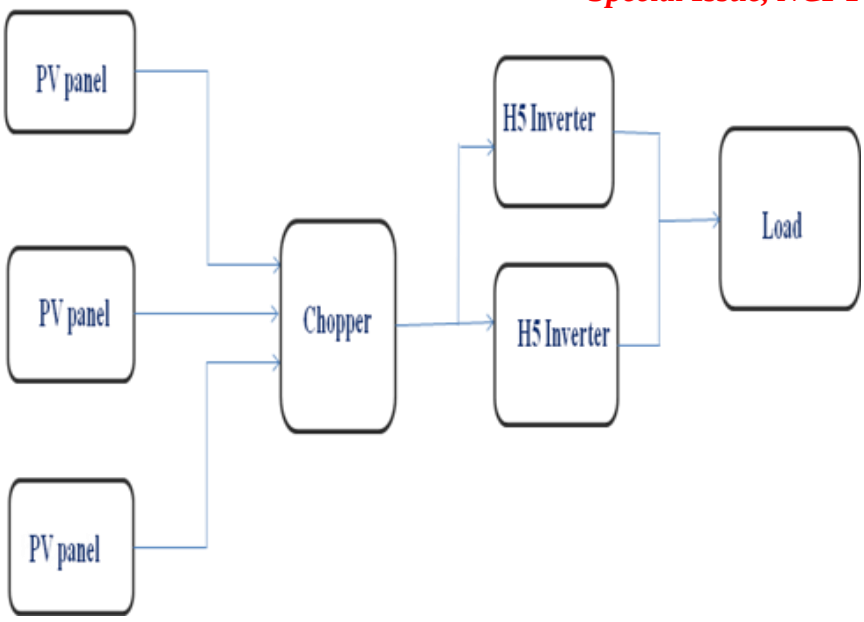

Figure 5: Block diagram for single chopper parallel H5 inverter

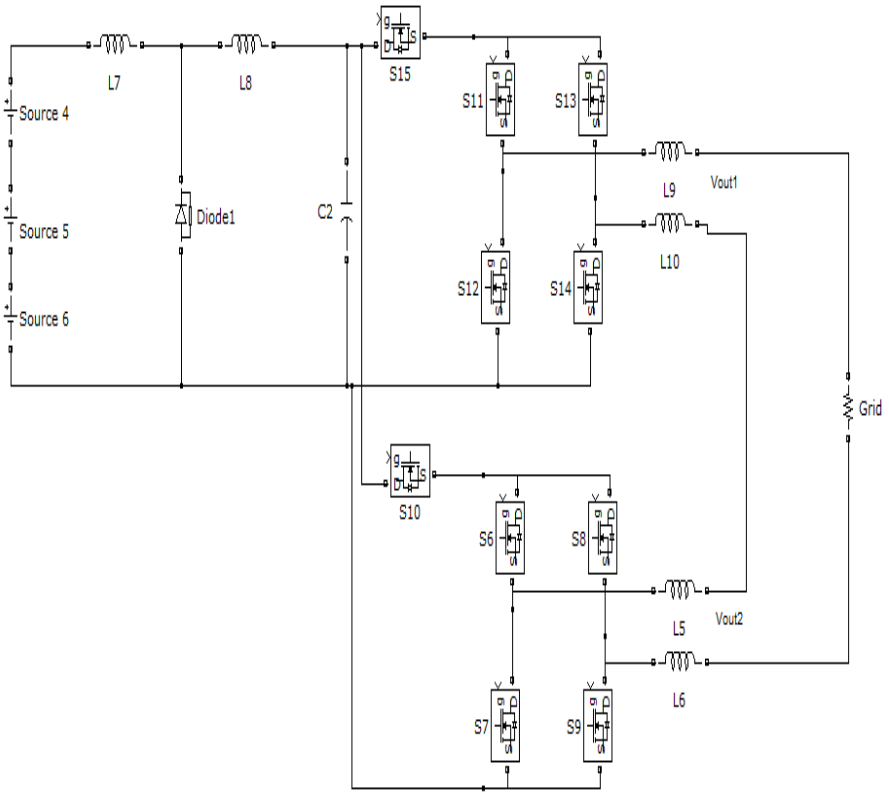

Figure 6: Circuit diagram for single chopper parallel H5 inverter

The major advantages of this proposed system is to reduce the cost, simplify the circuit and to reduce the leakage current.

4. Performance Analysis:

In order to prove the theoretical result, the experiment has done in MATLAB to get a proper simulation output graph for both existing and proposed method. The simulation outputs are given below in Fig. 7, 8, 9, the X-axis is time period (m sec) and Y-axis is output voltage (volts).

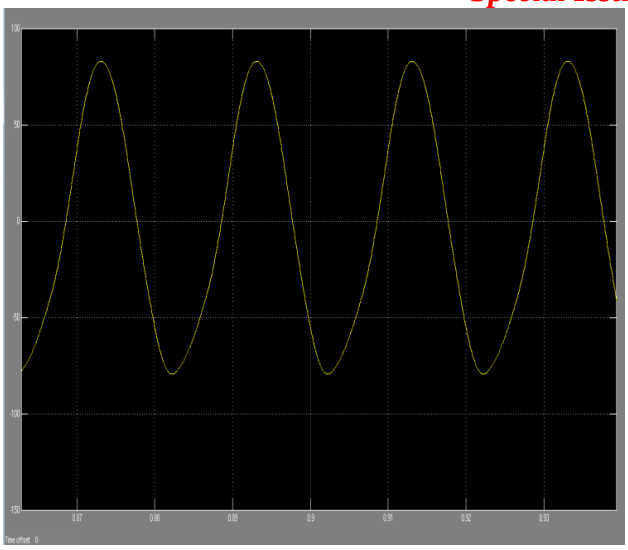

Figure 7: Simulation graph for transformer-less full bridge inverter

Voltage ripple for transformer-less full bridge inverter is 65% and efficiency produced is 75%.

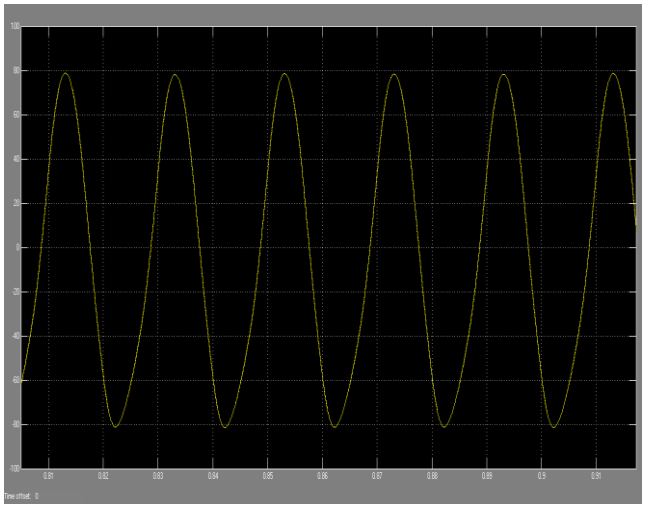

Figure 8: Simulation graph for single chopper single H5 inverter

Voltage ripple for single chopper single H5 inverter is 60% and the efficiency produced is 80%.

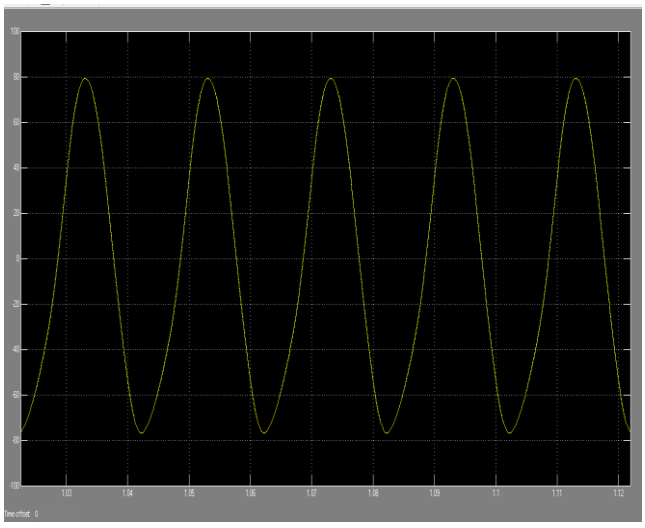

Figure 9: Simulation diagram for single chopper parallel H5 inverter

The voltage ripple for single chopper parallel inverter is 70% and the efficiency produced is 80%.

5. Estimation of Total Harmonic Distortion (THD):

This estimation is used to determine the harmonics present in the circuit. Due to harmonics, the output voltage is not efficient and losses are produced.

Here, the harmonics are analyzed with the help of Total Harmonic Distortion graph. The Harmonic Distortion graph are plotted below,

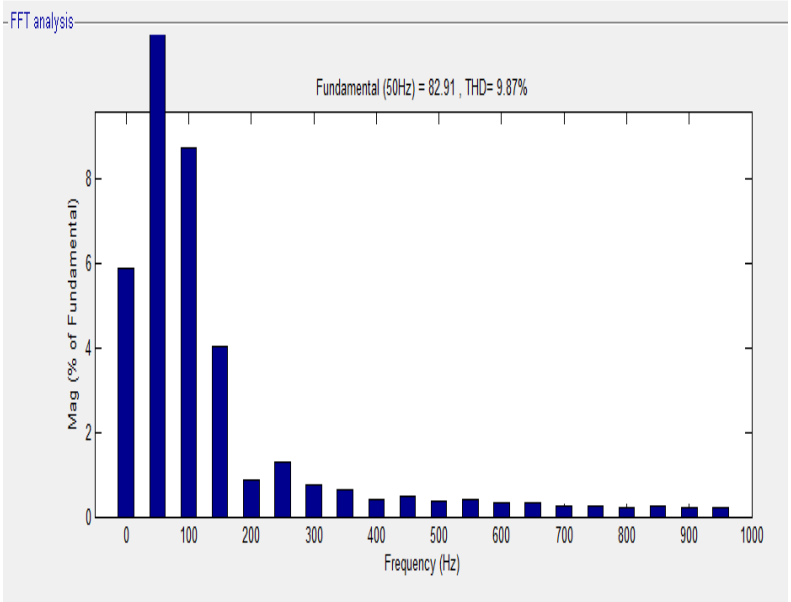

Figure 10: Total harmonic distortion for single H5 inverter

For the 50 Hz frequency, the Total harmonic distortion value (THD) for single H5 inverter is 9.87%.

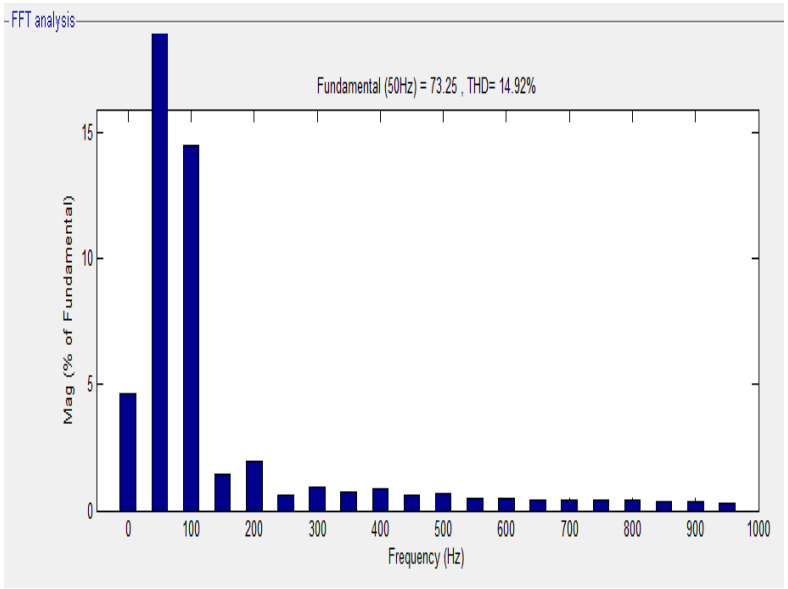

Figure 11: Total harmonic distortion for parallel H5 inverter

For the 50 Hz frequency, the Total harmonic distortion (THD) value for parallel H5 inverter is 14.92%.

6. Conclusion:

The single chopper with multiple input/single outputs is used to reduce the cost and the circuit is simplified. The analysis is made on single chopper single H5 inverter and single chopper parallel H5 inverter. This analysis is used to improve the

performance and to reduce the leakage current. The total harmonic distortion graph is estimated for both analyzes. The THD value for single chopper single H5 inverter is 9.87% and the THD value for single chopper parallel H5 inverter is 14.92%. Therefore the losses are less in SCSI. Hence the single chopper single H5 inverter is more efficient and convenient method compared to single chopper parallel H5 inverter. It is used in home appliances sand some industrial applications and also used in single and three phase transmission lines.

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