Selective Harmonic Elimination: A novel approach for harmonic elimination in Induction Motor

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***Abstract*: This paper presents a new energy efficient method of harmonic mitigation in a single-phase induction motor. This method is designed with a single-phase inverter in which extreme learning machine technique is used to obtain selective harmonic elimination by using pulse width modulation technique. The purpose is to eliminate undesired low-order harmonics present in the system. Algorithm is developed using MATLAB/Simulink and hardware is implemented. The output showed the potency of this method. Harmonics in the power system are generated due to the usage of nonlinear load. Core losses in the Induction machine, increases torque of the Induction motor, increase in the Skin effect, Damage of the induction motor insulation, Electromagnetic Interference Deviation in the induction motor Torque-Speed curve these are the effects of harmonics on the performance of induction machine. To eliminate these problems in Induction Motors we have designed this project to get soft operation and efficient output. The main target of this project is to increase efficiency and mitigate losses. In industrial areas and home appliances there is a wide use of Induction Motors, this work is targeted to reduce the noise, heating problem, power losses in induction motor.**

***Index Terms:* PWM - Pulse Width Modulation, Harmonics, Induction Motor.**

I. INTRODUCTION

Single phase system is more economical than a three phase power system hence we use single phase power system more for domestic, commercial and industrial purposes than three phase power system. And the power requirement is in most of the houses, shops; offices are small, which can be easily got by a single phase system. The single phase motors are simple in construction, cheaper in cost, reliable and easy to repair and maintenance because of these advantages, the single phase motor finds its application in vacuum cleaner, fans, washing machines, heating, ventilation, and air conditioner. Different methods can be used to control the speed of these motor. An induction motor's speed can be changed by the supply frequency and by the number of poles of the motor. Fluxes are produced by the slotting, windings, magnetic saturation, inequalities in the air gap length. In the rotor windings these harmonic fluxes induce voltages and introduce harmonic currents. The interaction between the harmonic currents generated in the rotor and the harmonics fluxes results in the harmonic torques, vibrations and the noise. Because of the use of nonlinear load harmonics get produced in the power system. These harmonics will affect the performance of induction motor which are core losses in the Induction machine increases, torque of the Induction motor reduces, increase in the Skin effect, damage of the induction motor insulation, electromagnetic interference, deviation in the induction motor torque-speed curves, power losses, heating problem, noise interference. To mitigate such harmonics we are using the method of selective harmonics elimination by PWM Inverter (ELM) based technique. This method is designed with a single-phase inverter in which extreme learning machine technique is used to obtain selective harmonic elimination by using pulse width modulation technique. In Inverters pulse width modulation technology is used because it gives a steady output voltage of 230V or 110V AC irrespective of the load. To calculate the Total Harmonic Distortion (THD), the quality of inverter output waveform is expressed by using Fourier analysis data. To eliminate these Induction Motors we have designed this project to get soft operation and efficient output. The main target of this project is to increase efficiency and mitigate losses.

II. LITERATURE SURVEY

ZeynepBalaDuranay, HanifiGuldemir et.al. this work presents a new method of energy efficient V/f speed control of single-phase induction motor. This method is designed with a single-phase inverter in which extreme learning machine technique is used to meet selective harmonic elimination pulse width modulation. In a low-speed region this method can produce a good speed adjusting performance, above nominal speed region. In all the operation, the selected low- order dominant harmonics which are the causes of additional losses are also eliminated which results a sinusoidal load current reducing the THD. [1] Gautam Ghosh, AbhilashaRathi, Angikar Roy, Chowdhury et.al. This work presents a conventional single phase inverter which offers a square wave output which when applied to electrical appliances may damage the components reducing its efficiency and life because this inverter output waveform is not sinusoidal and contains some lower and higher order harmonics in addition to fundamental. Inverters with this technique operate with low switching frequencies and it has a capability of elimination of lower order harmonics, hence SHE-PWM is highly advantageous for high power inverters than any other techniques that reduces the harmonics and generate high- quality output which results in minimum current ripple, reduced torque pulsations, improve overall performance by increasing the life and efficiency of the electrical appliances. [2]
SourabhKundu, Arka Deb Burman, SantuGiri, Sarbani Mukherjee et.al, this work introduces a modified selective harmonics mitigation scheme which is used to improve output power quality and equal power sharing among the H-bridge cells of a seven-level CHB Inverter. In this PWM method, dc sources are introduced as a variable along with the switching angles. From the results we can

say that the proposed SHM-PWM method improves the performance of the CHB inverter with respect to standard SHE-PWM method. [3] P Mamatha et.al. this work gives the information about different methods of multilevel inverter Also it gives detail information about the application of selective harmonic elimination pulse- width modulation (SHE-PWM) technique for thirteen-level cascaded sub multilevel inverters. To eliminate the low order harmonics from inverter output voltage the switching angles are computed such that the total harmonic distortion (THD) is a minimum. The modulation method is confirmed by MATLAB/Simulink software and the simulation results are discussed. [4]. Mohammad Sharifzadehet.al.this work introduces a modified Selective Harmonic elimination-Pulse Amplitude Modulation (SHM-PAM) which is capable of canceling all triplen harmonic orders and suitable for single-phase application of five-level type of voltage source inverter. The fifth and seventh harmonic orders are eliminated through normal operation of the given SHM-PAM technique. It is also shown that the given technique is used to other multilevel voltage waveforms and a self-elimination of all triplen harmonics. And the maximum number of harmonic orders would be controlled with the minimum number of available angles in a low switching frequency voltage waveform. [5]

III. SYSTEM DESCRIPTION:

The block diagram of the proposed system is as shown in figure 1. 230 volt 50 Hz AC supply is connected to single phase step down transformer. A transformer is a static device which transfers energy from one circuit to another circuit without changing its frequency but changing its current levels and voltage levels, step down transformer steps down the input voltage that is secondary side voltage is less than the primary side voltage. The output of step down transformer is connected to the single phase full wave bridge rectifier, rectifier converts AC energy into DC.

The output of single phase full wave bridge rectifier is given to the capacitor filter which removes the ripple content in DC supply and provides pure DC waveform, the output of Capacitor filter is given to the DC voltage regulator 5volt and 12volt, to maintain the constant voltage level. The output of 5volt regulator is given to the Atmega328 microcontroller, which provides time delay and controls the input signal of gate drivers, the output of microcontroller is given to the MOSFET gate drivers, the MOSFET gate drivers are provide gating signals to inverter circuit, inverter converts DC signal to AC signal, the output of inverter is given to the LC filter, the high pass LC filter passes the high frequency signal and attenuates the low frequency order. The output of LC filter is given to the step up transformer, it step up the output to 230 volt AC and the output of step up transformer is given to the single phase induction motor.

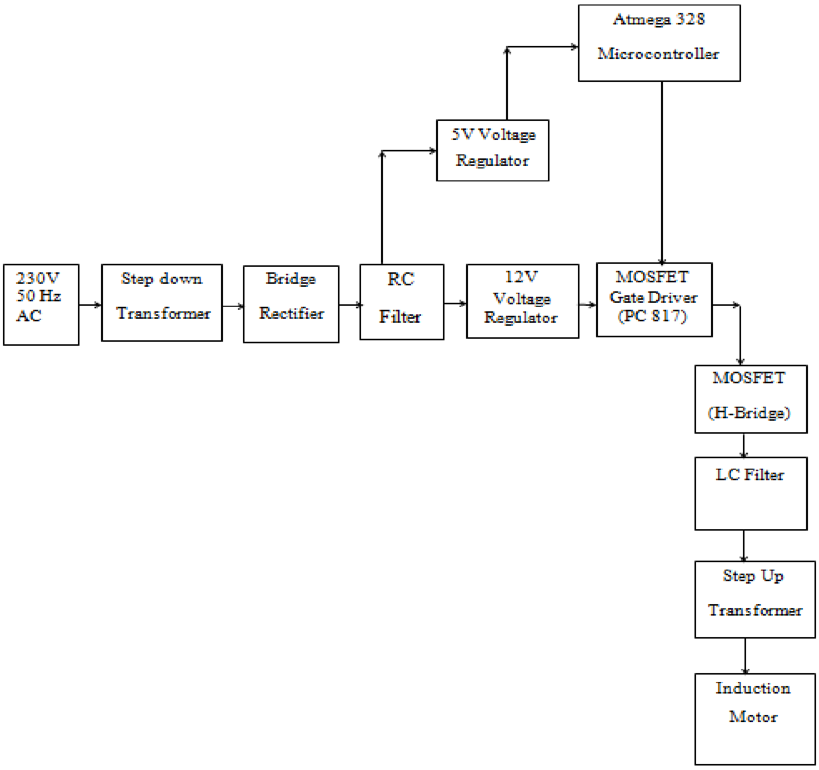

Figure 1. Block Diagram of Selective Harmonics Elimination by PWM Inverter Fed Single phase Induction Motor

IV. PROTEUS MODEL:

The proposed model has been simulated in Proteus software as shown in Figure: 2

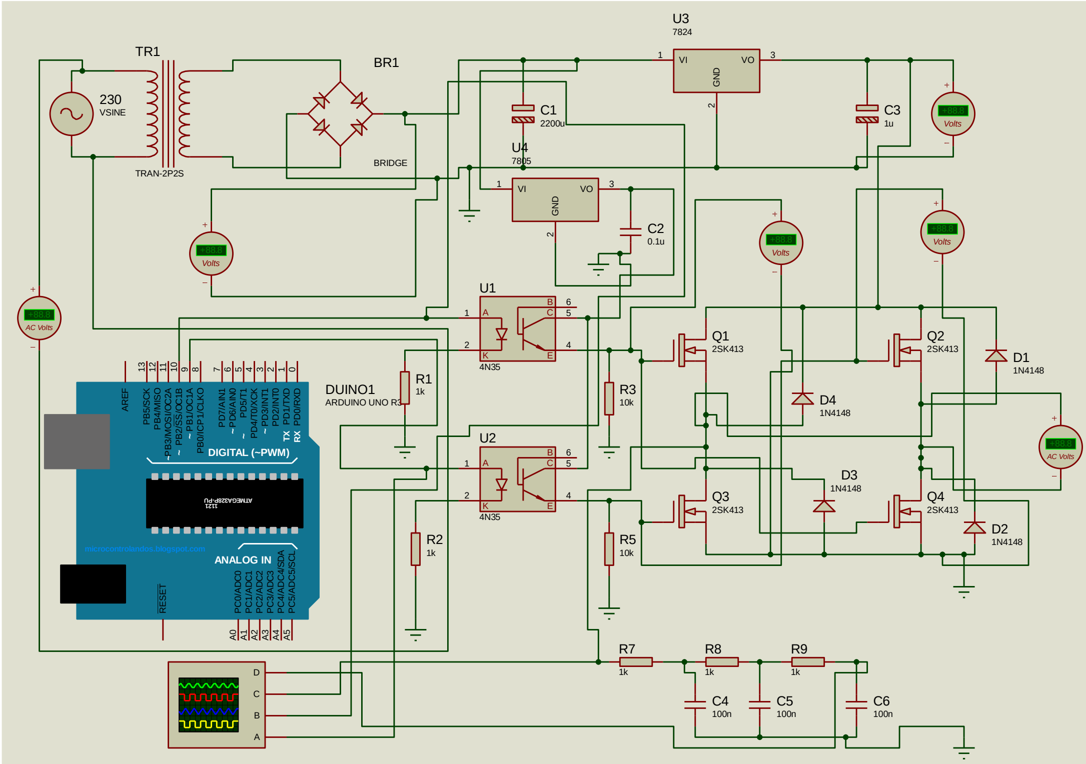

Figure 2: Proteus Model of SHE PWM

The proposed model has been simulated in MATLAB SIMULINK software as shown in Figure 3.

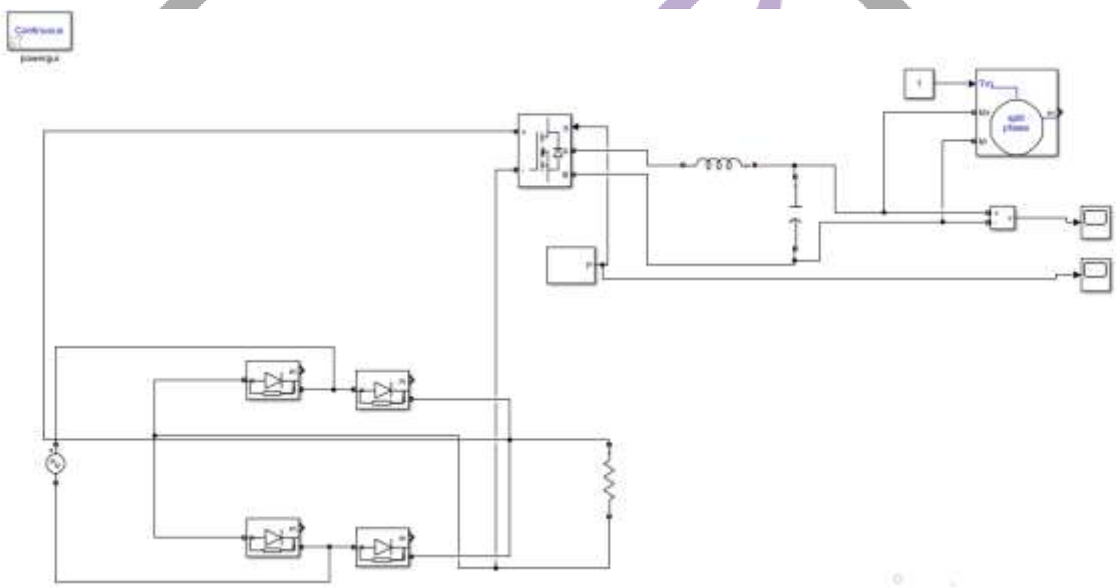

Figure 3: Simulink Model of SHE PWM

V. RESULTS AND DISCUSSION:

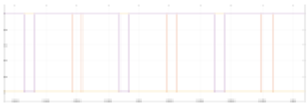

Figure 4: PWM Waveform

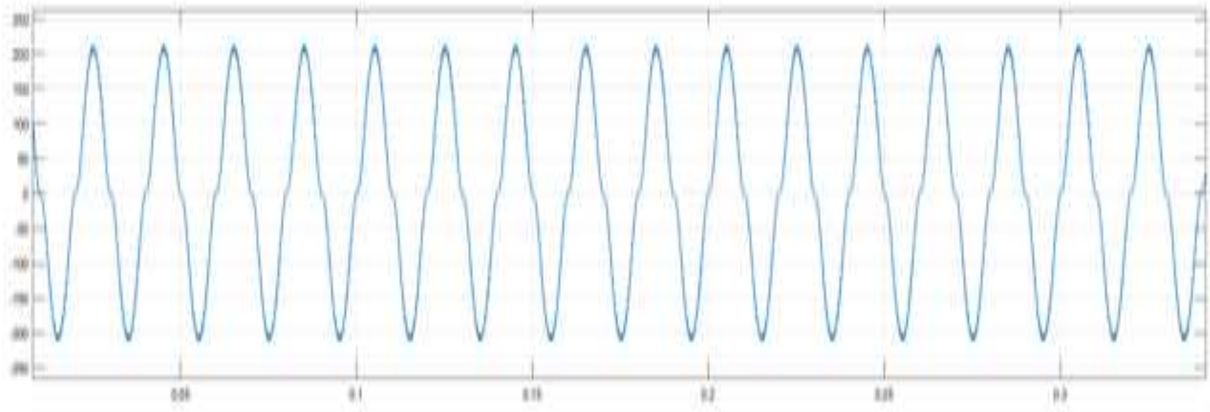

Figure 5: Output waveform of MOSFET H Bridge.

Harmonic contents are analysed using Fast Fourier Transform for different frequncy values as shown is following figures.

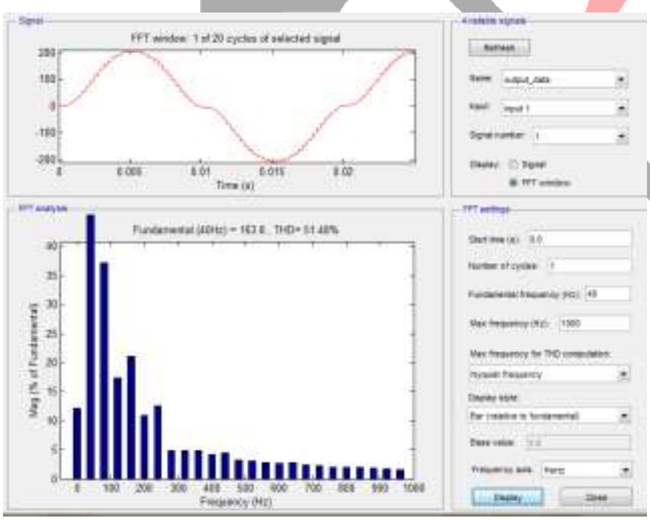

Figure 6: Frequency=40Hz ,THD=51.48%

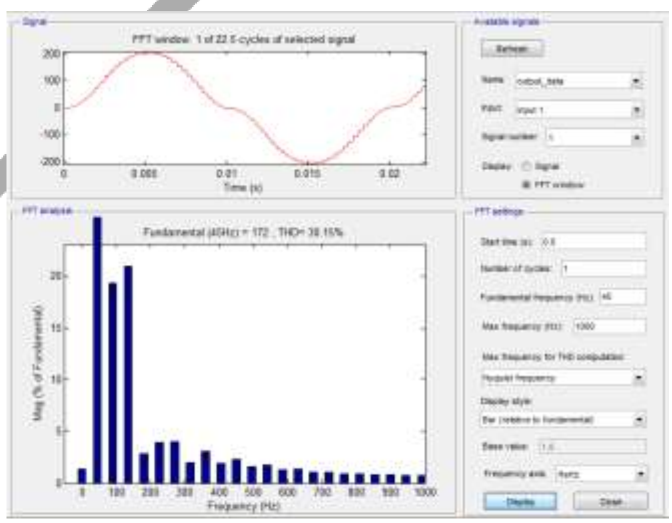

Figure 7:Frequency=45Hz THD=30.15%

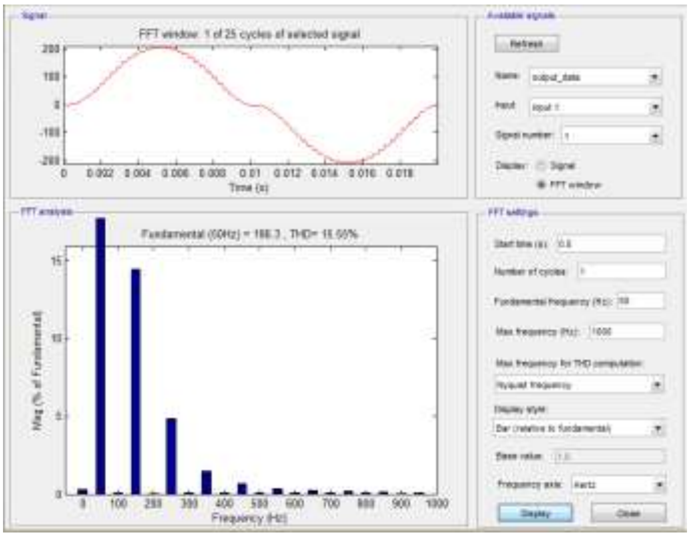

Figure 8:Frequency=50Hz,THD=15.55%

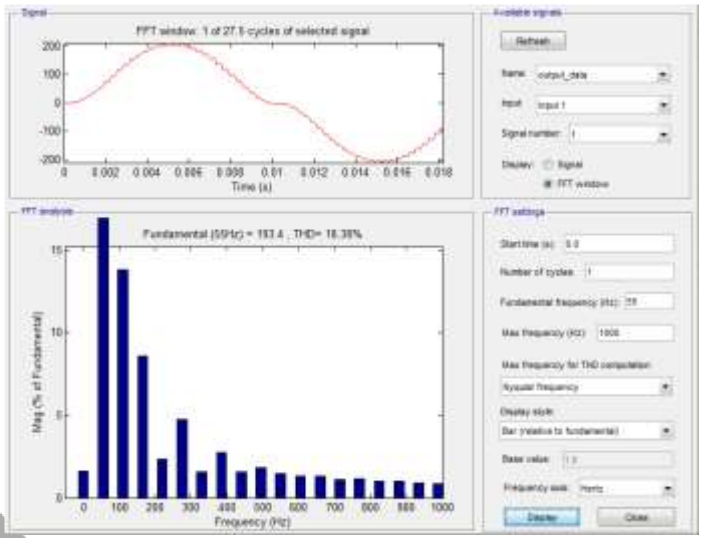

Figure 9:Frequency=40Hz ,THD=51.48%

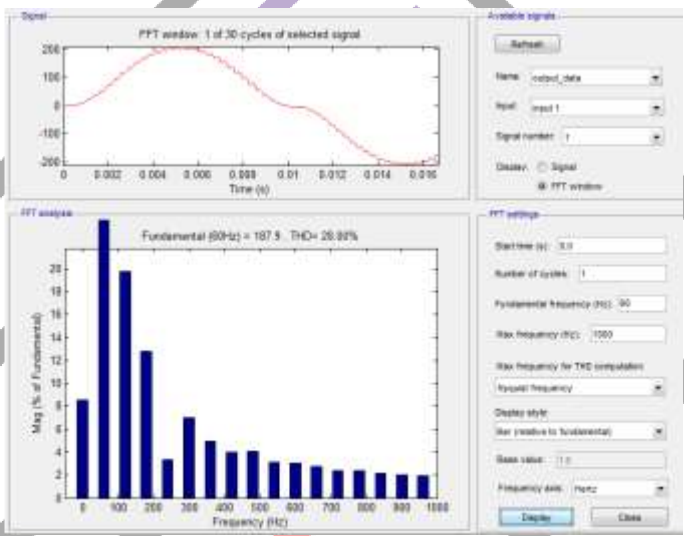

Figure 10: Frequency=60Hz ,THD=28.00%

The tabular form of results obtained for Total Harmonic Distortion is shown in Table 1 as follows.

Table 1: Total Harmonic Distortion at different Frequency.

Sr.No	Freq (Hz)	THD%
1	40Hz	51.48 %
2	45 Hz	35.15 %
3	50 Hz	15.55 %
4	55 Hz	18.38%
5	60 Hz	28.00%

VI. CONCLUSION:

Harmonics are Eliminated by using PWM technique and we get soft operation of induction motor,we eliminate the problem like heating, power losses, noise occurance and thus we increase the efficiency of Induction Motor.We are working with single phase split phase Induction Motor. In industries and domestic appliances, Induction Motor is widely used so where we use Variable Frequency Drive (VFD) we use SHE PWM.

VII. ACKNOWLEDGEMENT:

The authors would like to thank Dr.A.D. Jadhav, Principal, Mr. M.D. Patil, Head of Electrical Engineering Department, all faculty members and Management of Dnyanshree Institute of Engineering and Technology for their support and motivation in completing this work.

REFERENCES:

[1] ZeynepBalaDuranay, HanifiGuldemir, "Selective harmonic eliminated V/f speed control of single-phase induction motor" IET Power Electron (2017)

[2] Gautam Ghosh1,"Comparison of different techniques for selective harmonic elimination PWM in inverters – a review"IEEE©2017

[3] SourabhKundu ,"Implementation of Selective Harmonic Minimization PWM on Seven-Level Cascaded H-Bridge Inverter with Improved Inverter Performances and Equal Power Sharing Among Cells" IEEE ©2017

[4] P Mamatha, "Performance Improved Multilevel Inverter with Selective Harmonic Elimination". IEEE ©2017

[5] Mohammad Sharifzadeh, "Selective Harmonic Mitigation Based Self-Elimination of Triplen Harmonics for Single-Phase Five-Level Inverters" IEEE ©2018