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Analysis of results on power quality improvement by SPWM method

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***Abstract*— Power quality issues can be very high-speed events such as voltage impulses / transients, high frequency noise, waveshape faults, voltage swells and sags and total power loss. Each type of electrical equipment will be affected differently by power quality issues. This converter has been investigated for improved power quality and various simulation results have been presented to prove their effectiveness in terms of excellent power quality like nearly unity input power factor and negligible harmonic distortion of source current. The conventional Regular Sampled PWM technique can be simply extended to allow Harmonic Minimization and also Harmonic Elimination PWM. This survey paper will provide the insight of trends and technology of Power Quality Improvement using SPWM Technique**.

***Keywords*— SPWM (sinusoidal pulse width modulation), IPQC'S, Harmonics, Rectifier, Filter.**

I. INTRODUCTION

The best electrical supply would be a constant magnitude and frequency sinusoidal voltage waveform. However, because of the non-zero impedance of the supply system, of the large variety of loads that may be encountered and of other phenomena such as transients and outages, the reality is often different As a general statement, any deviation from normal of a voltage source (either DC or AC) can be classified as a power quality issue. Power quality issues can be very high-speed events such as voltage impulses / transients, high frequency noise, waveshape faults, voltage swells and sags and total power loss.Each type of electrical equipment will be affected differently by power quality issues.

Poor Power Quality can be described as any event related to the electrical network that ultimately results in a financial loss. Possible consequences of poor Power Quality include:

- Unexpected power supply failures (breakers tripping, fuses blowing).
- Equipment failure or malfunctioning
- Equipment overheating (transformers, motors, …) leading to their lifetime reduction.
- Damage to sensitive equipment (PC"s, production line control systems, …).

All this phenomena potentially lead to inefficient running of installations, system down time and reduced equipment life and consequently high installation running costs.The ac–dc conversion is used increasingly in a wide diversity of applications: power supplies for microelectronics, household electric appliances, electronic ballasts, battery charging, dc motor drives, power conversion, etc.

Ac–dc converters can be classified between topologies working with low switching frequency (line commutated) and other circuits which operate with high switching frequency.The simplest line-commutated converters use diodes to transform the electrical energy from ac to dc. The use of thyristors allows for the control of energy flow. The main disadvantage of these naturally commutated converters is the generation of harmonics and reactive power these power quality problems created by the widespread use of conventional diode bridge rectifiers and line-commutatedAC/DC converters have been discussed

These converters suffer from the drawbacks of harmonic generation and reactive power flow from the source and offer highly non-linear characteristics.

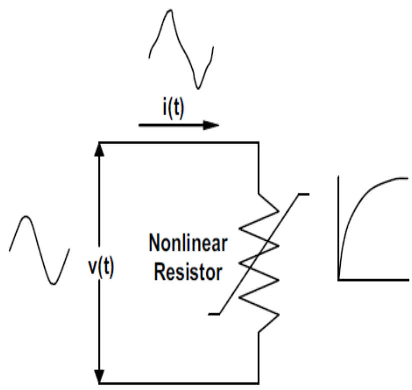

Figure 1

The generation of harmonics and reactive power flow in the power systems has given rise to the 'Electric Power Quality' problems. Harmonics are basically the additional frequency components present in the mains voltage or current which are integer multiples of the mains (fundamental) frequency. Harmonic distortion originates due to the nonlinear characteristics of devices and loads on the power system. All these disturbances may originate problems to both utility and customers. Among them, harmonic distortions are considered one of the most significant reasons for power quality problems.

II. RELATED WORK

Large number of solutions has also been proposed like static VAR compensators passive or active filters which would improve the quality of the power that is delivered to the mains.

Looking into the serious effects generated by conventional converters, the simple diode rectifiers should not be used. There is a need to achieve rectification at close to unity power factor and low input current distortion.

The challenges to be faced in the design of such AC/DC power supply are in achieving

- high power factor,
- low THD,
- high efficiency along with particular line and load conditions,
- high power density or reduced size,
- high reliability, and
- low system cost

This paper presents the modeling, simulation and analysis of an AC-DC converter based PWM rectifier. It provides a suitable control algorithm for a pulse width modulation rectifier which reduces ripple from the DC output side as well as shapes the input current properly. The basic objective of a PWM rectifier is to regulate the DC output voltage and also ensure a sinu. soidal input current and unity power factor operation.

Pulse width-modulation (PWM) rectifiers in distribution systems represents the best solution, in terms of performance and effectiveness, for elimination of harmonic distortion as well as power factor correction, balancing of loads, voltage regulation and flicker compensation. Sinusoidal PWM is a technique employed where the sinusoidal waveform or modulation signal is compared with a very high frequency triangle or carrier signal to obtain the switching pulses for the device.

This thesis presents SCR-based circuit extensionsto a diode rectifier to allow regeneration during braking. Regeneration into the ac mains is an attractive alternative for drives in systems such as conveyor belts, cranes and elevators, which need four-quadrant operation. The same semiconductng has conventionally been used to invert the regenerative power back into the mains.

III. PROPOSED WORK

The PWM Rectifier, by many is considered as most obvious alternative to conventional diode rectifier. The three phase VSC (Voltage Source Converter) applied as a grid interface stage called "Boost active rectifier, can take near sinusoidal input current with a near unity power factor but also it can work in both rectifying and regenerative modes. From the reliability and efficiency point of view a PWM Rectifiers are very promise solutions The power quality issues created by the use of conventional AC/DC converters are elegantly addressed by IPQCs. The output voltage is regulated even under the fluctuations of source voltage and sudden load changes. The PWM switching pattern controls the switchings of the power devices for input current waveshaping so that it becomes almost harmonic-pollution free and in phase with the source voltage, thus producing a nearly sinusoidal supply current at unity power factor without the need of any passive or active filter for harmonics and reactive power compensation.

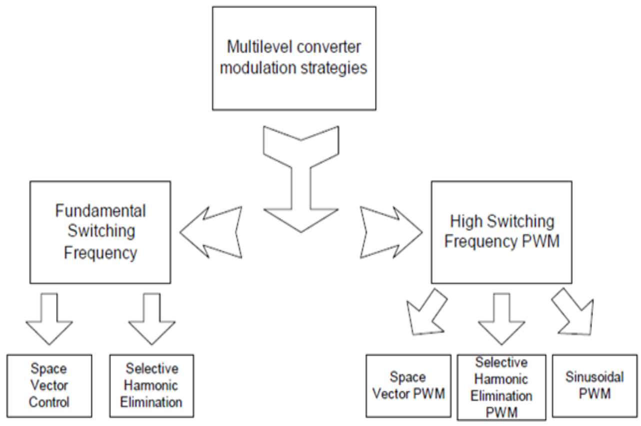

Figure 2

Due to the development of new grid codes, power converters' output signal harmonic control is currently becoming extremely important in medium and high-power applications. By taking this new scenario into account, a new method to generate switching three-level pulse width-modulation (PWM) patterns to meet specific grid codes is presented. The proposed method, which is named selective harmonic mitigation PWM, generates switching three-level PWM patterns with high quality from the point of view of harmonic content, avoiding the elimination of some specific harmonics and studying all harmonics and the total harmonic distortion as a global problem by using a general-purpose random-search heuristic algorithm. This fact leads to a drastic reduction or even avoidance of the bulky and costly grid connection tuned filters of power systems

IV. MATLAB SIMULINK MODEL DESCRIPTION

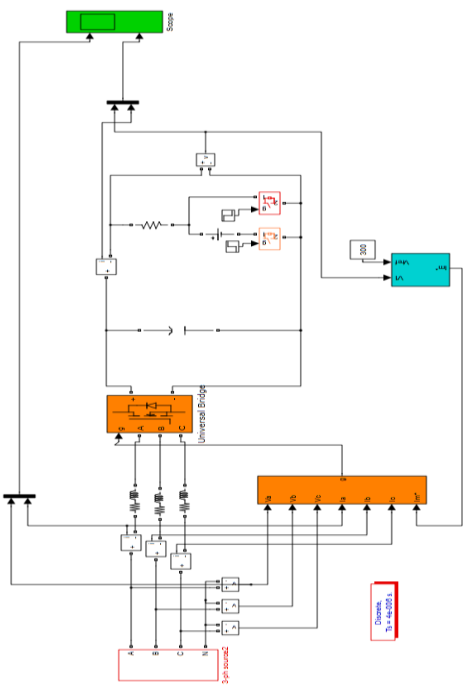

Fig 5. Simulink model for SPWM rectifier.

Simulation of various inverters using sinusoidal pulse width modulation was carried out with the help of "MATLAB 7.14"Simulation was carried out to observe the improvement in the Line current THD for RL load.Following quantities have been observed

V. DISCUSSION OF RESULTS

This chapter shows different scenarios that have been studied in order to support a simulation based design of an SPWM converter system capable to operate in stand Matlab/Simulink platform. It is composed of 6 sections.The total harmonic distortion (THD) analysis was done with Power Systems Toolbox

Case 1 : Waveforms of the nonsinusoidal supply voltage and load current for "phase-a" of the sample power system considered are shown in Fig.

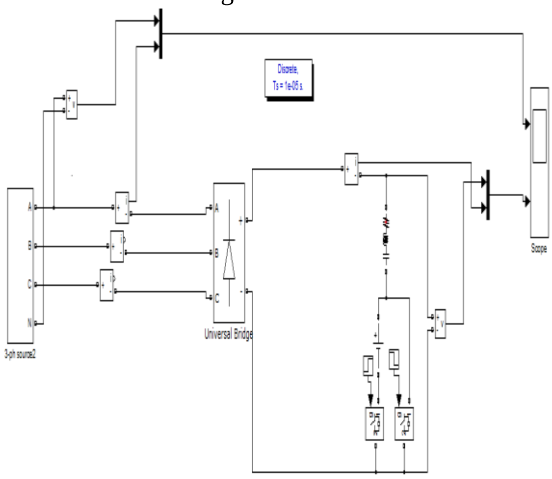

Fig5.1 Simulink model for diode brige rectifier.

we see input v has no effect but input current has.as we see before 0.6 sec voltage and current have +ive and –ive values and so power is transferred to dc side and after 0.6 sec voltage is +ive and current is zero and so no power flows from load to source –so no regeneration.therefore we observe that diode bridge rectifiers introduces ripples and current not sinusoidal so no regeneration.

The harmonic spectra of the source current (the same as load current) using diode rectifiers has been used.THD has been limited to 30.90% which is greater than IEEE standard..MATLAB-SIMULINK software is used for the verificationof the algorithm.

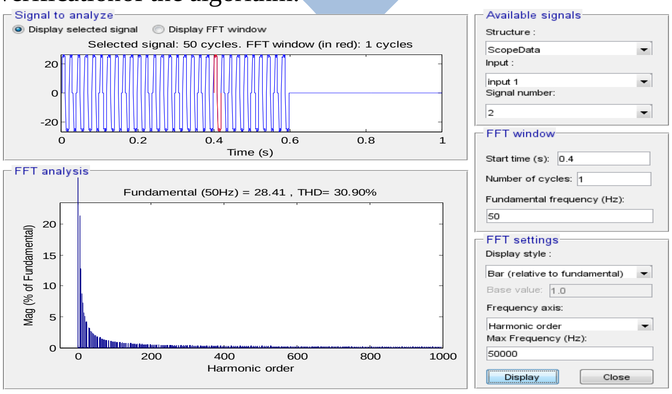

Fig5.2: 30.90% THD in case of diode bridge rectifier

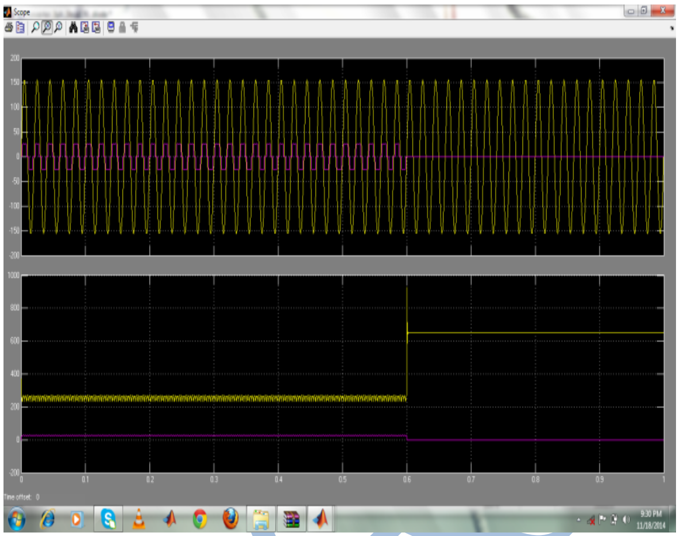

Fig5.3: Distortions in output in case of diode bridge rectifier.

CASE 2: In this model we observe that a capacitor filter is used on dc side.we can observe similar results in case of regeneration after 1 sec i.e. no regeneration.but in case of dc side voltage we observe that voltage is smoother because of capacitor and if we increase value of capacitor we observe more smoothing of dc but at athe same time variations in input current and source currnt current is non sinusoidal.

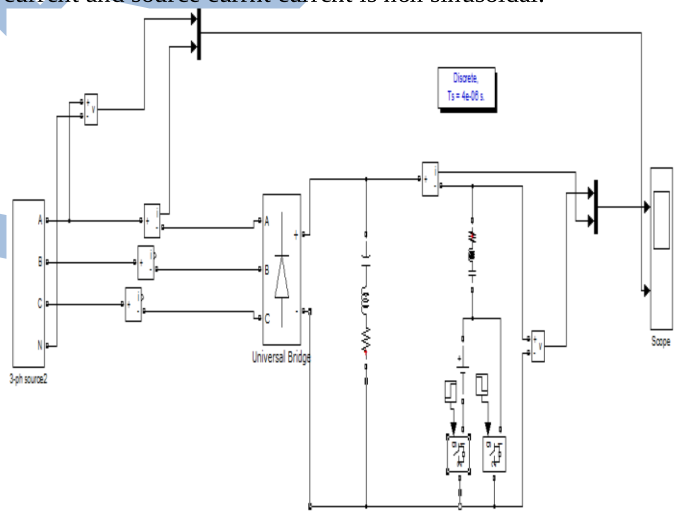

Fig5.4:Simulation model of 3 phase 2 level RL load capacitor filter

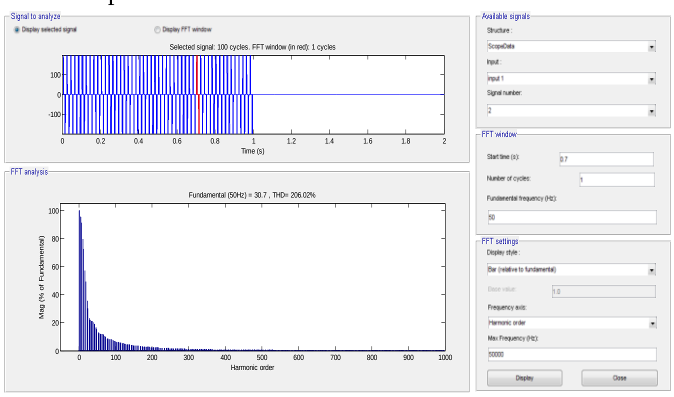

Fig5.5: THD is 206.02% using a capacitor filter

So we observe from FFT analysis that the THD is increased to 206.02%.

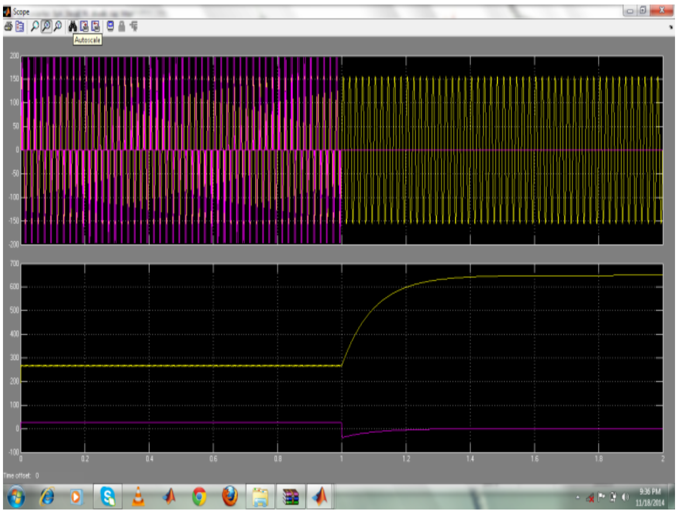

Figure5.6: Distortions in output by using capacitor filter

Case-3 In this model capacitor value is increased and on dc side lc filter is used.by the use of LC filter input current distortion is reduced.but it increases the weight of the system and also the cost is increased.the system is depicted in the following figure.

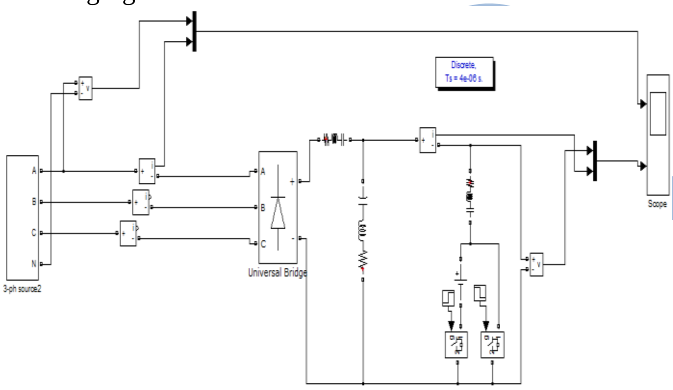

Fig5.7: Simulink model for diode brige rectifier using output filter

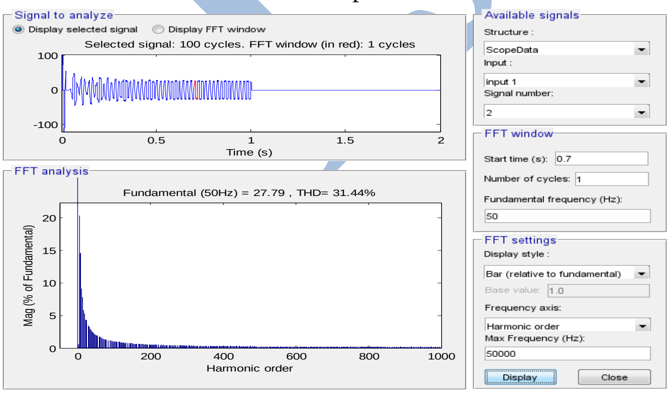

Fig5.8: THD is 31.44% using a output filter

Here we observe from FFT analysis that THD is reduced to 31.44%.

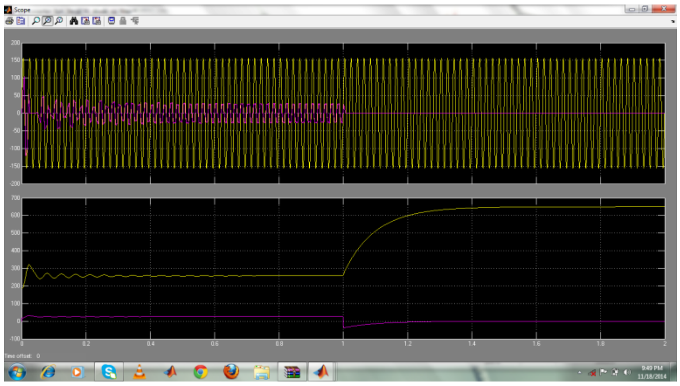

Fig5.9: input and output waveform using output filters

Case 4: 3 phase 2 level rl diode input filter rectifier is studied and analysed and it is found that by usingLC filter though input current variations is lessened but it creates ways for other problems such as problems of lead and lag.so if we are ridden of one problem it has already led to the creation of new problems.This system is modeled below…

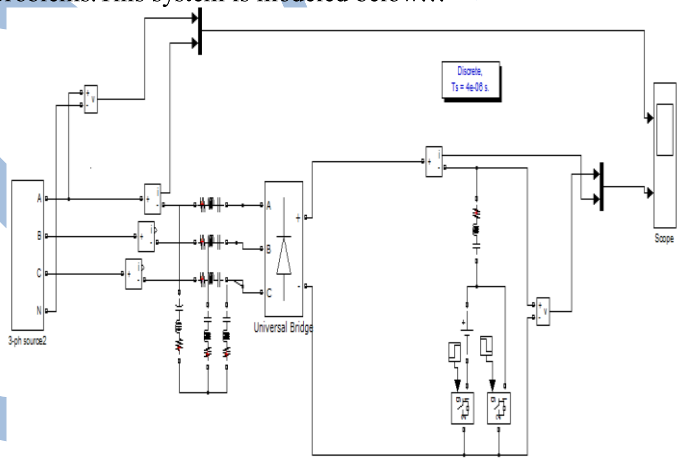

Fig5.10: Simulink model for rectifier using input filters

Below is given the waveforms observed in matlab-SIMULINK from which the results are clear.

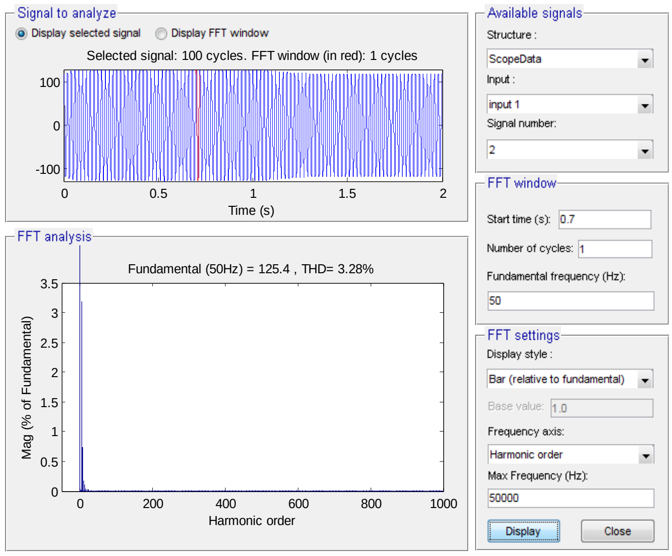

Fig5.11: THD is 3.28% using input filters

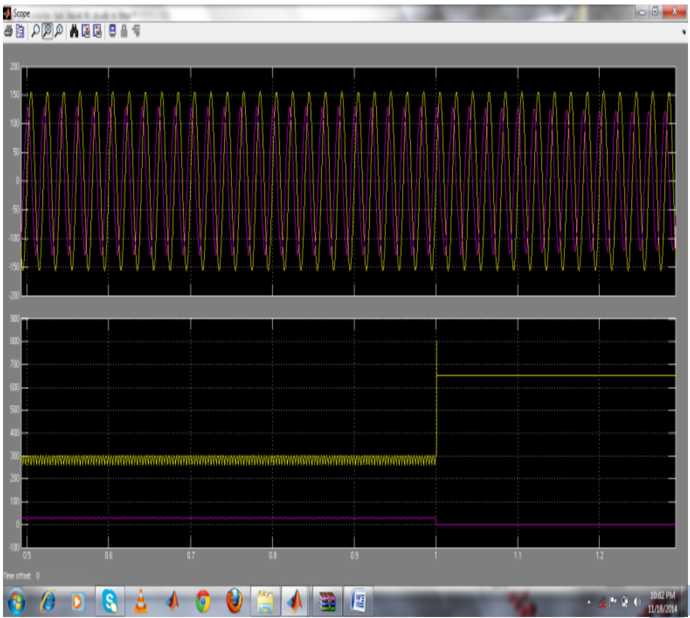

Fig5.11: input and output waveforms using input filters

From the FFT analysis we see the THD is reduced to 3.28% but already given way for other oter problems which reduce the quality of power further so we go for another approach.

Case 5: Here we have used filters at both input side as well as output side.at the input side LC filters are used and at output capacitor filter alongwith L filter is used. But it is seen that this combination leads to the power factor problems and a phase displacement is observed between input current and voltage although it gives improved results as input as well as output voltage and current is smooth. Laso it unnecessarily increases the cost ,size and weight of the system.the system is modeled below.

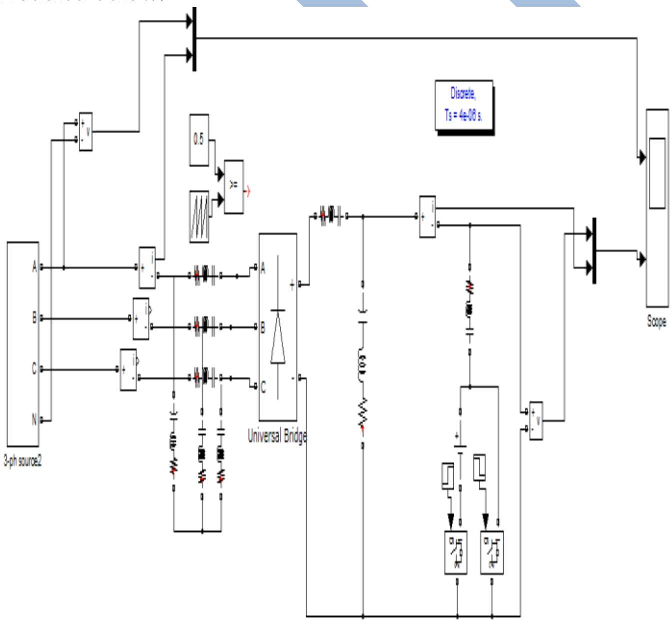

Fig5.12: Simulink model for rectifier with input and output filters

The waveforms and FFT analysis are presented below

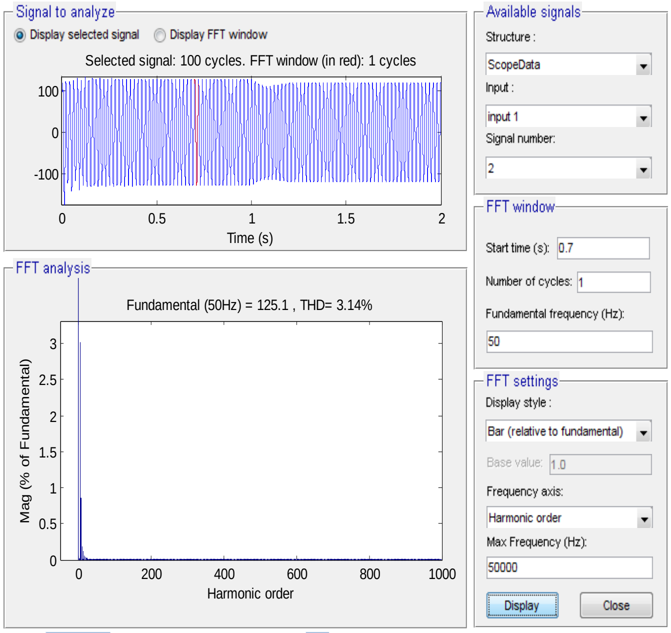

Fig 5.12 : THD is 3.14% using a input and output filters

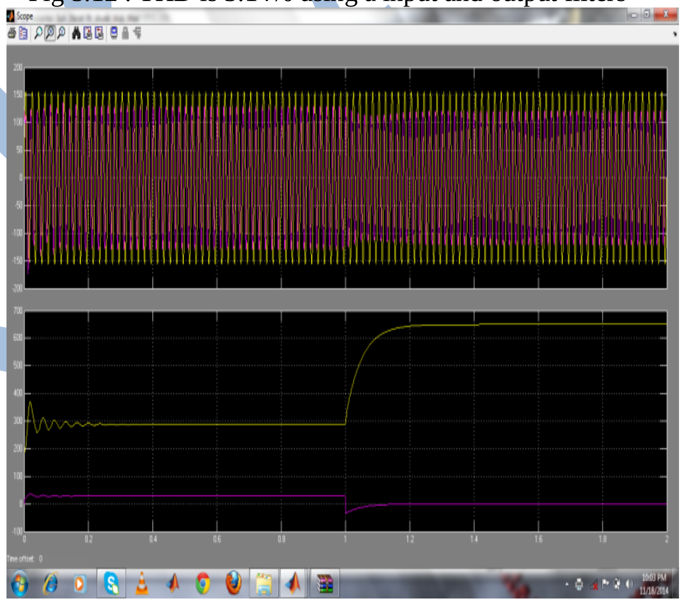

Fig 5.13:input and output waveforms using filters at both input and output

We observe the decrease in THD to a very large extent and its value as seen is 3.14%.

Case6: In this model which is the part under study and is most advanced above all universal bridge such as MOSFETs or IGBTs are used.these semiconducting devices have a gate point which needs to be controlled.so here current and voltage are predecided and does not need a step-down transformer which controls dc by controlling ac.the system is modeled in matlab and the waveforms observed are as shown below:

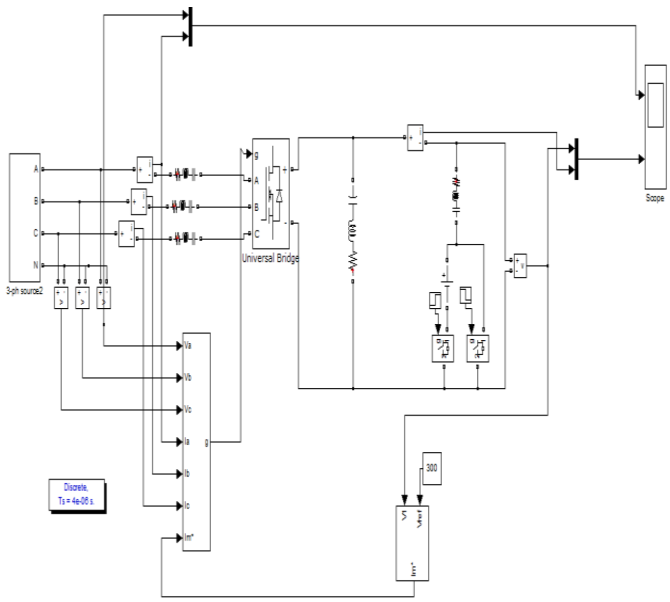

Fig5.14: Simulink model for diode brige rectifier.

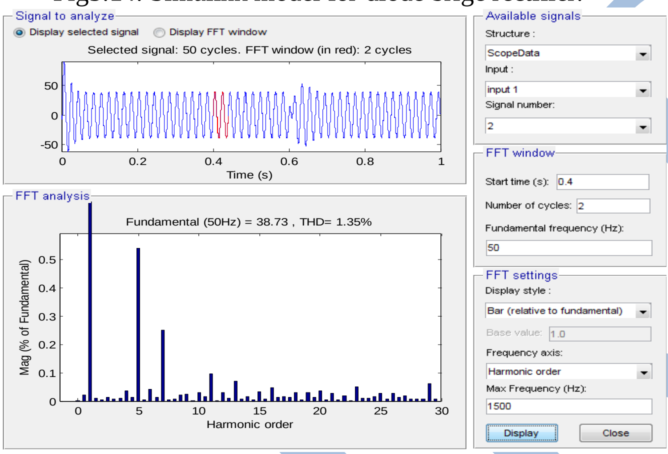

Fig 5.14:THD is observed as 1.35%

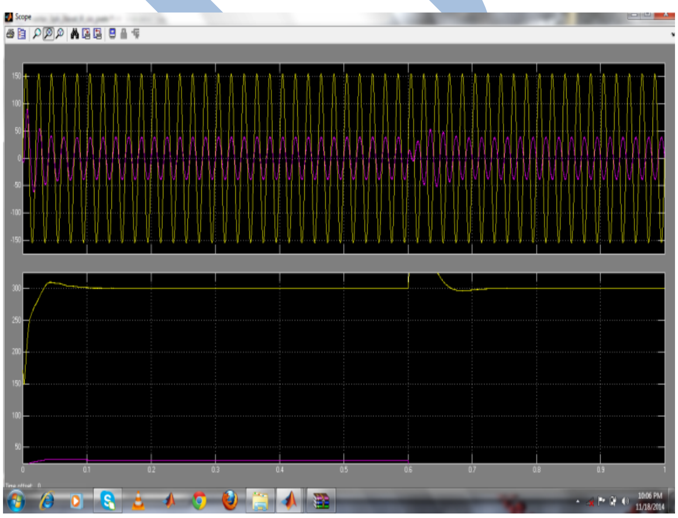

Fig5.15:input and output waveforms in case of spwm rectifier

The comparison of various methods used in above analysis is given below

Cases for comparision	THD (%)
diodes Rectifier	30.90
Rectifier using capacitor filter	206.02
Rectifier using output filter	31.44
Rectifier using input filter	3.28
Rectifier using both input and output filter	3.14
SPWM rectifier	1.35

Table 5.1

VI. CONCLUSION

The above analysis clearly proves that using the proposed algorithm, it is possible to limit the THD to minimum value and is within IEEE 519 which requires that THD be limited to 5% and thus proved that the THD is within the set limits.

REFERENCES

[1]. Shraddha Tiwari A. K. Sharma” Harmonics Voltage Stability and Power Quality Improvement Using PWM Compensation Technique” International Journal of Modern Engineering & Management Research Volume 1, Issue 1, April 2013

[2]. Sincy George, Member, IEEE, and Vivek Agarwal, Senior Member, IEEE”Optimum Control of Selective and Total Harmonic Distortion in Current and Voltage Under Nonsinusoidal Conditions”IEEE transactions on power delivery, VOL. 23, NO. 2, APRIL 2008

[3]. R. Navaneethan, E. Annie Elisabeth Jebaseel I”A Single Phase Ac-Dc Converter With Improved Power Factor And Harmonic Reduction” international journal of technology enhancements and emerging engineering research, vol 2, issue 3 ISSN 2347-4289

[4]. Shiuly Mukherjee, Nitin Saxena, A K Sharma”Power System Harmonic Compensation Using Shunt Active Power Filter.” Shiuly Mukherjee et al Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 7(Version 2), July 2014, pp.60-63

[5]. E.Jyothsna,D.Srilatha,B.Srinu “ reduction of harmonics by power theory based multilevel shunt active filter for power conditioners” E Jyothsna * et al. ISSN: 2250-3676 [IJESAT] [International Journal of Engineering Science & Advanced Technology] Volume-3, Issue-5, 210-216

[6]. M.T. lamchich,M.Raoufi” A fuzzy logic based controller for shunt power active filter” Journal of Electrical Engineering

[7]. Bhim Singh, Senior Member, IEEE, Brij N. Singh, Member, IEEE, Ambrish Chandra, Senior Member, IEEE, Kamal Al-Haddad, Senior Member, IEEE, Ashish Pandey, Student Member, IEEE, and Dwarka P.

Kothari, Senior Member, IEEE" A Review of Single-Phase Improved Power Quality AC-DC Converters" IEEE transactions on industrial electronics, VOL. 50, NO. 5, october 2003

[8]. Charles S *Member* ACEEE" Power Quality Enhancement in Variable Frequency Drive using Hybrid Filters- An Shunt Passive and Series Active Combination" International Journal of Recent Trends in Engineering, Vol 2, No. 5, November 2009

[9]. Aslam P. Memon, Ahsan Zafar, M. Usman Keerio, Waqar Ahmad Adil, Asif Ali. A" Experimental Study and Analysis of Harmonics Generation in Uncontrolled and Controlled Rectifier Converters" International Journal of Scientific & Engineering Research, Volume 5, Issue 1, January-2014 ISSN 2229-5518

[10]. Hussein A. Kazem, MIEEE, MIEE, Abdulhakeem Abdullah Albaloshi, Ali Said Ali Al-Jabri, and Khamis Humaid AlSaidi" Simple and Advanced Models for Calculating Single-Phase Diode Rectifier Line-Side Harmonics" World Academy of Science, Engineering and TechnologyInternational Journal of Electrical, Robotics, Electronics and Communications Engineering Vol:1 No:9, 2007

[11]. Avneet Kaur, Prof. S.K Tripathi, Prof. P. Tiwari" Study of Power Factor Correction in Single Phase AC-DC Converter" International Journal of Emerging Trends in Electrical and Electronics (IJETEE – ISSN: 2320-9569) Vol. 5, Issue. 1, July-2013.

[12]. Rajendra Aparnathi, Ved Vyas Diwedi"Study of the LCL Filter for Three Phase inverter in higher stability for the Active damping Method using Genetic Algorithm Base." International Journal of Advancements in Technology http://ijict.org/ ISSN 0976-4860Vol. 4 No. 1(March 2013)©IJoAT

[13]. Mihaela Popescu, Alexandru Bitoleanu, and Mircea Dobriceanu" On the AC-Side Interface Filter in Three-Phase Shunt Active Power Filter Systems" World Academy of Science, Engineering and Technology Vol:4 2010-10-20

[14]. A. Reznik,M.Godoy Simões,Ahmed Al-Durra,S. M. Muyeen"LCL Filter Design and Performance Analysis for Grid Interconnected Systems"

[15]. L. A. Serpa and J. W. Kolar, S. Ponnaluri, P. M. Barbosa" A Modified Direct Power Control Strategy Allowing the Connection of Three-Phase Inverter to the Grid through LCL Filters".

[16]. Marco Liserre, Member, IEEE, Frede Blaabjerg, Fellow, IEEE, and Steffan Hansen, Member, IEEE" Design and Control of an LCL-Filter-Based Three-Phase Active Rectifier" IEEE transactions on industry applications, VOL. 41, NO. 5, September/october 2005

[17]. Mani Ratnam Tarapatla, M Sridhar, ANVJ Raj Gopal"Shunt Active Power Filter Implementation Using Source Voltage and Source Current Detection" Mani Ratnam Tarapatla, M Sridhar, ANVJ Raj Gopal / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 6, November- December 2012, pp.645-650

[18]. P.Gani Raju, Veda Kumar.N" Power Quality Improvement in DC Drives Using Matlab/Simulink" International Journal of Wisdom Based Computing, Vol. 1 (2), August 2011

[19]. Riya Philip" Synchronous Reference Frame Detection and Hysteresis Control for Active Power Filters" International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering(An ISO 3297: 2007 Certified Organization)Vol. 3, Issue 9, September 2014

[20]. Sandeep G J S M, Sk Rasoolahemmed" Importance of Active Filters for Improvement of Power Quality" International Journal of Engineering Trends and Technology (IJETT) - Volume4Issue4- April 2013.

