ISSN: 2455-1848
International Journal of Innovative Research & Growth
A Peer Reviewed & Referred International Journal
Volume-7 Issue-3 July-2018
Impact Factor-3.0
www.ijirg.com, editor@ijirg.com

A Review On Power Quality Control For Non Linear Loads

[1]Khushbu Chaturvedi, [2]Garima Goswami, [3]Pankaj Kr. Goswami
[1]M.Tech Scholar, Dept of Electrical Engineering, Jaipur National University, Jaipur, Rajasthan, India
[2]Associate professor, Dept of Electrical Engineering, Jaipur National University, Jaipur, Rajasthan, India
[3]Associate Professor, Dept of Electronics Engineering, Jaipur National University, Jaipur, Rajasthan, India
Email- Khushboochaturvedi5@gmail.com, grmsinha@gmail.com, g.pankaj1@gmail.com

Abstract
In recent years non linear loads are widely used in domestic or industrial purpose because of these non linear loads different types of issues arise in our system like voltage sag, swell, harmonics, power factor etc. so different types of methods are being used resolve the problems. The increasing consumption of the nonlinear loads e.g. rectifiers, power electronic converters and modern industrial automation development cause various unexpected events in the power system. These loads draw currents with the lag power factor, and rise harmonics and reactive power in an electric power supply. This behavior leads to a voltage distortion and affects on other loads connected to the same point. The loads are unbalanced and nonlinear & may draw harmonic currents. Moreover, results also presented for reactive power and non-linear load compensation. Here researcher used different methods for power quality control and twenty five papers for the power quality control.
Keywords:- *DSTATCOM,Powerquality MATLAB/SIMULATION, THD, Active power filters.*

1- INTRODUCTION

Now-days most of the loads in industry, homes, agriculture are inductive in nature like induction motors, ceiling fan, agricultural pumps etc. In the case of these inductive loads currents drawn by the loads from source is lagging with respect to the voltage. So the reactive power burden on the system increases, which will increase losses in the distribution system and capacity of active power flow through the distribution system gets reduced. Due to advancement of power electronics technology, non linear loads in the system are increasing, such as rectifiers, inverters, uninterruptible power supply (UPS), computers, etc. These Non-linear loads can cause the production of frequency component of the currents in the system which is not fundamental frequency components. So due to such harmonic component of currents the quality of power gets affected. Also, there is the impact of the unbalancing on transformers and generators operation. The solution to power quality improvement is the use of custom power device like DSTATCOM.

2- LITERATURE REVIEW

[DINESH KUMAR ET. Al 2005] describes the modeling and analysis of distribution static compensator (DSTATCOM), which is capable of balancing the source currents in spite of unbalanced and nonlinear load currents. In addition to balance the supply current, the power factor can be set to a desired value. The theory of instantaneous symmetrical components is used here to extract the three-phase reference currents. These reference currents are then tracked using voltage source inverter (VSI), operated in a hysteresis band control technique. The

detailed simulation results are presented to support the concept. The two-level and three level inverter topologies are used to realize the compensator. It is demonstrated that three level inverter gives less total harmonic distortion (THD) in source currents as compare to two level inverter. Disadvantage of this method is that it has been carried out only for sinusoidal steady state conditions. Thus, this method can only eliminate fundamental reactive power in steady state. In fast Fourier transform (FFT) technique, the Fourier transform is performed on the sample load current waveform .A current waveform is then synthesized that has the same harmonics components as the load current with the opposite phase angles.

[NEVEDITA S PANDE et. Al 2014] presents Distribution Static Compensator (DSTATCOM) configuration in three phase four wire system, using three levels Neutral Point Clamped (NPC) inverter operated in current control mode for load compensation to enhance the quality of power. The behavior of shunt compensator is analyzed using Synchronous Detection method. The purpose of this compensating scheme is to provide completely balanced and sinusoidal source currents under unbalanced and distorted source conditions. The chosen control algorithm includes three different approaches-equal current, equal power and modified equal current. The above said criteria are compared graphically and analytically for unbalanced and non-linear load condition. Results obtained show that modified equal current approach is more effective than the other two even if the source voltages are severely distorted and unbalanced. For realization, an extensive digital simulation is done using MATLAB environment an advantage that, power factor angle can be explicitly set to any desired value. In high power high voltage applications two level inverters have some limitations such as higher harmonic content, large filter requirement, high dv/ dt stresses.

[PD DEBRE et.al 2015] discussed different conventional voltage source inverter (VSI) topologies for High voltage distribution system to realize Distribution Static Compensator (DSTATCOM). The reference currents are extracted through instantaneous symmetrical component theory. To check the performance of DSTATCOM for high voltage distribution system, different inverter topologies are implemented under unbalanced and non-linear load conditions. The purpose of shunt compensator is to balance the load, as well as make the supply side currents sinusoidal with unity power factor. Considering the benefits of Hysteresis current control pulse width modulation (PWM), it is used to generate the gating signals for all the inverter topologies. The performances of DSTATCOM using various inverter topologies for the high voltage distribution system are discussed. . The hysteresis PWM is found to be beneficial, since it is having characteristics fits simplicity, ease of implementation, peak current limiting capability, faster response and providing dynamic response etc.

[MANJATHAU VALAPIL MANOJ KUMAR et.al 2015]discussed a new three leg voltage source inverter(VSI) based distribution static compensator (DSTATCOM) topology to compensate unbalanced and no linear loads for low voltage three phase four wire distribution system . This topology uses three leg VSI with a single DC storage capacitors. And an additional small AC capacitor which is connected between negative bus to the system neutral as the use of single dc link capacitors DC voltage balancing issues is associated the disadvantages of this topology is the use of more no. of VSI switches and lack of independent control of different inverter leg.

[R. P. Ton dare et.al 2017] discussed different inverter topologies for Low voltage distribution system by using DSTATCOM. The reference currents are generated by using instantaneous symmetrical component theory to control

the switching devices using hysteresis current control pulse width modulation the loads are unbalanced and nonlinear & may draw harmonic currents. The purpose of shunt compensator is to balance the load, as well as make the supply side currents balanced and sinusoidal with unity power factor. In this paper, the compensator is realized using conventional inverter and the effects of different inverter based DSTATCOM topologies for the low voltage distribution system are analyzed. Comparative analysis of inverters on the basis of performance is discussed. The advantage of this topology is that the rating of capacitor will be reduced and it gives better results. But the limitation of this control is varying switching frequency. It can be observed that switching frequency is higher for lower value of hysteresis band &vice versa. Hysteresis band selection is very crucial and it depends on the interface inductor, system voltage, dc link voltage and switching frequency of inverter.

[SR MALLA et.al 2017] investigates the dynamic operation of novel control scheme for Distributed Static Synchronous Compensator (DSTATCOM) with 9-level inverter. The performance of proposed controller is simulated by the MATLAB/Simulink. The DSTATCOM scheme and the electric grid network are modeled by specific electric blocks from the power system block set, while the control system is modeled using Simulink. In this paper 9 level converter is used instead of 48 pulse converter for DSTATCOM operation in distributed system. In general 48 pulse converter requires 8 transformers and 8 six pulse converters. Hence, it is expensive and complex in operation. In order to overcome these problems, proposed 9 level multilevel inverter based DSTATCOM and it is tested under balanced and unbalanced load condition. Moreover, results also presented for reactive power and non-linear load compensation. In our proposed structure have only one transformer and single 9 level converters; therefore, operation in controlling is very easy and cost effective compare to general configuration. These switching technologies are considerable advantages in terms of cost, performance, efficiency, and fast controllability.

[RITU SHARMA et.al; 2017] discussed, a 3-leg voltage source inverter (VSI) based Distribution Static Compensator (DSTATCOM) is used for load compensation in 3-phase 3-wire distribution system. The control algorithm is based on Synchronous Reference Frame (SRF) algorithm. This algorithm is used for extracting the reference source currents for power factor correction, load balancing and harmonic reduction. Tuning of PI (Proportional Integral) controller is done using trial and error method and also by Zeigler- Nichols (Z-N) method. Simulations are performed for various load conditions such as a reactive linear load, an unbalanced load and non-linear load. Power factor correction mode (PFC) for DSTA TCOM is tested in MA TLAB environment using SIMULINK and Simper system toolbox. The power factor correction mode of DSTATCOM has been achieved for load compensation with SRF algorithm and two different methods of PI controller tuning. The DC bus voltage of DST A TCOM has been regulated to its reference value for various loading conditions. In simulation, it is found that the performance and response of controller is fast and effective in power factor correction mode for compensating the linear balanced/unbalanced load and nonlinear balanced/unbalanced load using Zeigler-Nichols method for PI controller tuning.

[MR. SHARAD S PRASAD et.al 2017] presents Distribution Static Compensator (DSTATCOM) modeled in the MATLAB SIMULINK toolbox for the mitigation of the power quality issues in the distribution system. DSTATCOM is one of the custom power device used in distribution system for power conditioning. DSTATCOM is

developed for the compensating reactive power demanded by non-linear and unbalanced load. Also power factor of the source is improved and the Total Harmonic Distortion in the source currents is reduced. DSTATCOM can correct voltage sag, swell, unbalance by injecting the reactive current into the system. Instantaneous reactive power theory is used for obtaining reference source current for controlling DSTATCOM. The performance of the DSTATCOM by using the IRP theory for unbalanced and nonlinear load is demonstrated with the MATLAB simulation results.

[A ROHINI et.al 2017]discussed synchronous reference frame theory controlling strategy is presented to generate reference current utilizing four-leg three-phase four-wire Distribution Static Compensator (DSTATCOM). An adaptive hysteresis band current controller is proposed to control the hysteresis bandwidth according to the modulation frequency, supply voltage, DC capacitor voltage and slope of the reference compensator current wave. DSTATCOM is used to compensate reactive power, neutral current, harmonic elimination and balancing load currents. The performance of these methods is investigated using Matlab/Simulink software under various load conditions considering IEEE standard 519-1992 recommendations for three-phase four-wire distribution systems. The results show appropriate compensation performance under linear and balance load as well as unbalanced and non-linear load conditions for proposed strategies. Advantages of Hysteresis band current controller PWM method has been widely used because of its simplicity comparing to the other PWM techniques. In addition to fast response and peak current limiting capabilities, this technique doesn't require precise knowledge of the system parameters. Disadvantages of conventional hysteresis band current controller are that the switching frequency varies within a band and increases switching losses in the system. To avoid this limitation an adaptive band hysteresis current controller is proposed. This controller can be programmed to optimize the performance of the switching device as a function of the load and source parameters. This optimization will cause a considerable reduction in switching losses.

[A NAVEEN KUMAR et. Al 2015] discussed The use of renewable energy sources for the generation of electricity is been extensively used these days due to many aspects like to reduce pollution, to meet load demands, extinction of conventional fuels and many more. This paper gives a detailed analysis of grid connected renewable source in a three phase four wire distribution system with power quality improvement feature. Power quality is necessary where there is a presence of non-linear loads. A 4-leg voltage source inverter (VSI) connecting renewable source and grid serves two purposes: as inverter to invert the output of renewable source to supply power to the grid and as power conditioner. The control scheme presented here to control the VSI effectively conditions the power in 3-phase 4-wire distribution system. The system performance was analyzed with different load conditions like balanced and unbalanced non-linear loads. Also the system was tried out with Switched Reluctance Motor (SRM) drive system and the performance was found to be satisfactory. All the models and results were carried out using Mat lab/Simulink software. Such disadvantage can be overcome using active power filters which induce compensating currents in to the system to regulate the harmonics. The inverter used to invert the DG output can be used as active filter also without separate accessories needed. In this paper the inverter has two objectives, one is to invert the output of the DG and the other is to mitigate harmonics, performing as a filter to ensure system efficiency will be high with safe and reliable operation.

[T R AYODELE ET. Al 2017] discussed

the increased use of non-linear loads such as lighting technologies (bulbs) has led to power quality variation of distribution networks. In recent times, different lighting technologies are finding their ways into the market. As such, it is paramount to evaluate the performance characteristics of these lighting technologies and the possible effects they might have on the power network. In this paper, three lamp technologies i.e. Light Emitting Diode (LED) lamps, Incandescent Lamps (IC) and Compact-fluorescent lamps (CFL) are analyzed to check the impact of their usage on the power quality of a distribution system through a laboratory experiment. The result revealed that the LED lamps offer the highest savings in energy consumption compared to CFLs and ICs. However, they (LED lamps) constitute the highest harmonic pollution in comparison to the other lamps. From the study, it seems no single lamp is preferable when considering energy saving and power quality at the same time. The choice would have to depend on which of metrics is under consideration. In cases where power quality issues is of prime importance, traditional incandescent lamps are the most preferred, on the other hand when energy conservation is the focus, the LED lamps are the most favorable. CFLs offer moderate energy savings and produce fewer harmonics compared to the LED.

[M D SHIRAJUM 2017] describers —the increased non-linear loads in today's typical home are a growing concern for utility companies. This situation might be worsened by the harmonic resonance introduced by the installation of capacitor banks in the distribution network. To mitigate the harmonic distortions, passive or active filters are typically used. However, with the increasing implementation of distributed generation (DG) in residential areas, using DG systems to improve the power quality is becoming a promising idea, DG systems, has photovoltaic (PV), wind and fuel cells, have DG-grid interfacing converters. In this paper, the potential for using photovoltaic (PV) interfacing inverters to compensate the residential system harmonics is explored. A system model including the residential load and DG is first developed. An in-depth analysis and comparison of different compensation schemes based on the virtual harmonic damping impedance concept are then carried out. The effects of the capacitor banks in the system are also studied. The effectiveness of the harmonic compensation strategies under different conditions is verified through analysis and simulations.

[M D SHIRAJUM 2017] describers — increased non-linear residential loads in today's distribution system is a concern due to the harmonics related power quality issues. The situation gets worsened by the harmonic resonance introduced by the installation of power factor correction (PFC) capacitor banks in the distribution network. At the same time, more and more renewable energy-based distributed generation (DG) units are being installed in the residential area. These DG systems can be used as an effective way to mitigate the harmonic related power quality problems introduced by the nonlinear residential loads. In literature, very limited work has been done to identify harmonic compensation priorities that should be assigned to different DGs operating at different locations of the distribution system for improved compensation performance. This issue is addressed in this paper. A selective harmonic compensation scheme based on modal analysis is developed to assign compensation priorities on DGs operating at different distribution system nodes for improved compensation performance. A modeled residential distribution system containing distribution components such as distribution line, PFC capacitors, transformers, and household appliances along with DG units is used to verify the improvement of compensation

performance. Experimental verification of the proposed method is also provided.

[R.R OLIVERA ET. AL2006] discussed this paper aims at investigating electrical and mechanical performance of three-phase salient pole synchronous generator with unbalanced and non-linear loading. The time domain technique is employed to represent the three-phase synchronous generator. By studying the generator operation with non-ideal AC load conditions, the machine electrical and mechanical impacts caused by unbalances and harmonics are evaluated and discussed. Besides theoretical studies, experimental results obtained from a 2kVA three-phase prototype were derived so as to validate the computational approach and conclusions. Finally, by using a real size generator of 25MVA, more realistic results are computationally achieved and discussed.

[MONALISA PATNAIK ET. AL 2012] discussed an improved control algorithm for a standalone double output induction machine based variable speed constant frequency generator the algorithm ensures sinusoidal load voltage and machine stator current for all types of load unbalanced ;balanced nonlinear and linear in any arbitrary combination

[THIAGO B. SOEIRO ET. AL 2012] discussed —this paper presents the analysis, design, and experimental performance verification of a serial type line conditioner. Since it processes only a fraction of the load power, the overall converter losses tend to be lower and the efficiency of the conditioner higher. Regarding the dynamic performance, the line inductance, which results in a positive zero in the transfer function of the plant, is taken into consideration when designing a voltage controller with higher bandwidth for faster response. In addition, a virtual resistance is included in the control of the system to damp oscillations often seen for operations at light load and with nonlinear load conditions. Experimental results obtained with a 10 kVA prototype of a serial line conditioner fed from the load side and the proposed feedback control scheme are presented to demonstrate the superior performance of the line conditioner.

[MR. DEEPAK KUMAR 2015] discussed -Subsisting as one of the most promising energy resources, the exploitation of the solar energy in the favor of mankind is proliferated. The photovoltaic (PV) generation is a kind of dc current source, a dc electrical energy, which is connected to the utility-grid through power-electronics interfacing devices such as DC-DC converter and inverter. The controlling technique is advantageously applied owing to control the voltage source inverter without actually employing the current source inverter. The presented grid connected PV system (100 kW) is simulated in the MATLAB/SIMULINK environment and analyzed for changing environmental conditions. For maximum utilization of the studied PV system (under different illuminations and panel temperatures), maximum power point tracking based on perturb & observe algorithm has been adopted in the present work. The system is tested under normal, heavy and non-linear loading conditions and the simulation results have proven the integrity of the controller to maintain the unity power-factor of the grid. The use of L-C-L third order filter plays the key role to reduce the total harmonic distortion to the value of 1.74%.

[JULIO CESAR LOPEZ 2012] —This paper presents a model for long-term reactive power planning where a deterministic nonlinear model is expanded in to a multi-stage stochastic model under load uncertainty and Dan N-k contingency analysis. Reactive load shedding is introduced in the objective function to measure the reactive power deficit after the planning process. The objective is to minimize the sum of investment costs (IC), expected operation costs (EOC) and reactive load shedding costs optimizing these resend location so f new reactive

compensation equipment to ensure power system security in eachstagealongthe planning horizon. Anefficientscenariogenerationandreduction methodology issue formodelinguncertainty. Expected benefits are calculated to establish the performance of the expected value with perfectionformation (EVPI) and the value of the stochasticsolution (VSS) methodologies. Theefficiency of the proposed model is tested and justified by the simulation results.

[M P SELVAN ET. AL 2011] discussed a comparative analysis of performance of Series Active Filter (SAF) under different operating conditions such as non-sinusoidal supply and nonlinear loading. Two control schemes like PI controller based Sinusoidal Pulse Width Modulation (SPWM) switching and hysteresis voltage controller based switching have been employed in the comparative study. The percentage total harmonic distortion of the compensated load voltage has been considered as a measure for comparison. It has been observed from the simulation results under various operating conditions that the performance of SAF with hysteresis voltage controller is better.

[WEIN WANG ET. AL 2013] discussed the existence of virtual impedance; the load harmonic current would decrease the detection accuracy of fundamental power calculated in DQ method; thus influence the performance of drop control system in micro grid inverters quantitative analysis of the fundamental power detection error is conducted and general expression of inverter output power in the presence ofvirtual impedance are established. The concept of virtual harmonic power is proposed to approximately describe the error.

[A NAVEEN KUMAR ET. AL 2016] discussed The use of renewable energy sources for the generation of electricity is been extensively used these days due to many aspects like to reduce pollution, to meet load demands, extinction of conventional fuels and many more. This paper gives a detailed analysis of grid connected renewable source in a three phase four wire distribution system with power quality improvement feature. Power quality is necessary where there is a presence of non-linear loads. A 4-leg voltage source inverter (VSI) connecting renewable source and grid serves two purposes: as inverter to invert the output of renewable source to supply power to the grid and as power conditioner. The control scheme presented here to control the VSI effectively conditions the power in 3-phase 4-wire distribution system. The system performance was analyzed with different load conditions like balanced and unbalanced non-linear loads. Also the system was tried out with Switched Reluctance Motor (SRM) drive system and the performance was found to be satisfactory. All the models and results were carried out using Matlab/Simulink software.

[Thiago B. Soeiro et.al] discussed the design, and experimental performance verification of a serial type line conditioner. Since it processes only a fraction of the load power, the overall converter losses tend to be lower and the efficiency of the conditioner higher. Regarding the dynamic performance, the line inductance, which resultsinapositivezerointhetransferfunction of the plant, is taken into consideration when designing a voltage controller with higher bandwidth for faster response. In addition, a virtual resistance is included in the control of the system to damp oscillations often seen for operations at light load and with nonlinear load conditions. Experimental results obtained with a 10 kVA prototype of a serial line conditioner fed from the load side and the proposed feedback control scheme are presented to demonstrate the superior performance of the line conditioner.

[K. Venkatraman et. Al] presents a comparative analysis of performance of Series Active Filter (SAF) under different

operating conditions such as non-sinusoidal supply and nonlinear loading. Two control schemes like PI controller based Sinusoidal Pulse Width Modulation (SPWM) switching and hysteresis voltage controller based switching have been employed in the comparative study. The percentage total harmonic distortion of the compensated load voltage has been considered as a measure for comparison. It has been observed from the simulation results under various operating conditions that the performance of SAF with hysteresis voltage controller is better.

[KARUPPANAN P et.al] presents a PI, PID and Fuzzy Logic Controller (FLC) based shunt active filter for power line conditioners (PLC) to improve the power quality in the distribution network. This active power filter is implemented with current controlled cascaded multilevel voltage source inverter (VSI). It is connected at the point of common coupling for compensating harmonic and reactive power by injecting equal but opposite harmonic compensating currents. The reference current extraction is based on sensing main currents only, which require current harmonics and reactive volt-ampere compensation. The PI or PID or fuzzy logic controller is used to estimates the peak reference current by controlling the dc-bus capacitor voltage of the cascaded inverter. The cascaded multilevel inverter switching signals are derivates from triangular-sampling current controller; it gives a good dynamic performance under steady state and transient operations. The cascaded active filter system is validated through extensive simulation under steady state and transient conditions with different non-linear loads. These simulation results have been revealed that the cascaded active power filter performs perfectly in conjunction with PI or PID or FLC. A comparative assessment of these three different controllers is disclosed.

3- CONCLUSION

A number of scientific research papers have been reviewed based on various issues. Total twenty five papers have been reviewed related to five different issues involving power quality improvement using DSTATCOM , power quality improvement using PV system , harmonic analysis using grid VSI, , Future scope of power quality improvement. Power Quality now is the important issue now days. The main cause of power quality problems are power electronics equipment's, information technology equipment's, adjustable speed drive (ASD) etc., because of which load causes disturbance in voltage waveforms and the issue arises like voltage sag, voltage swell etc. The issues related to currents are unity power factor, voltage regulation (combine called as load compensation), neutral current compensation, and harmonic current compensation. Distribution static compensator (DSTATCOM) is the most popular custom power device to suppress the effect of poor load power factor, harmonics, dc offset of loads, unbalanced loads. The purpose of compensator is to inject current in such that to cancel out harmonics and dc component of the loads. In distribution system loads are unbalanced and nonlinear which causes unbalanced and distortion to the supply.

Power distribution systems should have the capability to provide uninterrupted power supply to fulfill increasing power demands. But most of the loads in industrial or commercial applications are non-linear loads and are sensitive enough to break continuity of power supply. In addition to this they are responsible for creating power quality disturbances such as harmonic currents, excessive neutral current, load unbalancing etc. Also, when source voltages are unbalanced and distorted. It may significantly affect the quality of power thus making it a matter of concern in power distribution network. Various custom power devices are becoming popular solutions in order to mitigate such power quality disturbances. A shunt connected DSTATCOM is more

popularly used which is capable of compensating the aforementioned disturbances effectively. DSTATCOM comprises of Voltage Source Inverter (VSI) as the main component. Several two level inverter topologies have been developed in the last two decades.

4- ACKNOWLEDGMENTS

The authors acknowledge the support and encouragement of faculty members of electrical engineering department, Jaipur National University, Rajasthan, India.

5- REFERENCES

[1] R. P. Ton dare et.al "Analysis of inverter topology in shunt application for nonlinear loads" Nagpur 2013 IEEE.
[2] Shiva Ganesh malla et.al "9 level GTO converter" IEEE2016.
[3] Ritu Sharma et.al "Power quality improvement using PI controller" DELHI 2014 IEEE.
[4] Mr. Sharad s panwar et.al "Modeling of DSTATCOM" MAHARASHTRA 2015 IEEE.
[5] A. Rohani et.al "PQ improvement in 3p4w system" May 20-22, 2014, Shahid Beheshti University.
[6] Manjathau valapill et.al "Three leg inverter based DSTATCOM for nonlinear loads" IET 2015.
[7] Dinesh Kumar et. Al "Analysis of DSTATCOM for nonlinear loads" IEEE 2015.
[8] A. S. O. Ogunjuyigbe et.al "LAMP TECHNOLOGY" IEEE 2017.
[9] Deepak Kumar "PV system grid for nonlinear loads" Dhanbad IEEE 2015.
[10] JulioCésar Lopezet.al "Reactive power planning" IEEE 2012.
[11] R. R. Oliveira et.al "3 phase synchronous generator for nonlinear loads"IEEE 2006.
[12] Monalisa Patnaik et. Al "Double output induction generator"IET 2012.
[13] Thiago B. Soeiro et.al "Line conditioners for nonlinear loads"IEEE 2012.
[14] K. Venkatraman et.al "Active filters for nonlinear loads" IEEE 2011.
[15] Wen wang et.al "Micro grid inverter controller for nonlinear loads"IET 2013.
[16] Zong et.al "Parallel active filter for nonlinear loads" IET 2008.
[17] A.Naveen Kumar et.al "PQ improvement of SRM drives" IEEE 2016.
[18] Md Shirajum Munir et.al "Residential distribution system using PV system"IEEE 2013.
[19] Md Shirajum Munir et.al "Residential distribution system using power electronics DG"IEEE 2016.
[20] Nivedita Pande et.al "Control of DSTATCOM"IEEE 2014.
[21] Nivedita pande et.al "Inverter topology for high voltage distribution system"IEEE 2015.
[22] Ats Haas et.al "Analysis of electricity meter"IEEE 2012.
[23] Thiago B. Soeiro et.al "Improved conditioners for nonlinear loads"IEEE 2012.
[24] M. P. Selvan et.al "Filters for nonlinear loads"IEEE 2011.
[25] KARUPPANAN P et.al "PI, PID, FUZZY LOGIC for nonlinear loads" IEEE 2011.