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Optimum Power Control And Quality Management In Dg- Integrated System

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Abstract:-*Our main focus of this paper is to control the active power supplied by distributed generation (DG) system while reducing and compensating harmonics & reactive currents caused by the nonlinear loads using shunt active power filter (APF). The APF control is basically based on load currents which sense the reference current estimate in a-b-c reference frame. The active power transfer is the function of power angle and the reactive power transfer is the function of voltage magnitude difference between the inverter voltages and the grid voltages. The widespread simulation for the study is carry out with the help of MATLAB / Simulink to show the usefulness of algorithm. Various types of simulation results are presented with integrated modes of operation for distributed generation system interfaced with grid.*

Keywords*: distributed generation , active power filter, harmonics, reactive power, power quality.*

I.INTRODUCTION

Renewable energy source (RES) is integrated at distribution level it is termed as distributed generation (DG). The demand of power and use of the energy is increasing which boosting the interest in power system. Hence expanding electric generating capacities by using distributed energy generation (DEG). The utility is concerned due to the high penetration level of intermittent RES with in distribution systems as it may poses a threat to network in terms of stability, voltage regulation and (PQ) power-quality issues. Therefore, DG systems are required to comply with strict technical and regulatory frameworks is to ensure safe, efficient and reliable operation of overall network. With the advancement in power electronics and the digital control technology, DG systems can now be actively controlled to enhance the system operation with improved PQ at PCC. The main purpose of the distributed generation system connected with a grid is to control the power that the inverter injects into the grid. According to the grid demands the controller injected the reactive power. Distributed generation (DG) surround a wide range of prime mover technologies, such as internal combustion micro turbines, photovoltaic,(IC) engines, gas turbines, fuel cells and wind-power. These distributed generators are characterized mainly by their location and by their low nominal power rating(less than 1 MW). The integrated DG along with the grid system can solve typical problems of conventional AC network, such as energy security, it can reduces transmission and high voltage equipment cost *etc.* However, when it is operated in stand-alone mode a small DG has important problems of voltage and frequency variation. Therefore a small DG should be interconnected with the power system to maintain the frequency and the voltage.

Power electronics loads produce different power quality problems such as unbalancing, harmonics, excessive neutral current, etc. Figure-1 shows the harmonic voltage distortion in point-of-common-coupling (PCC) due to the harmonic currents flow through the system impedance. These power quality problem causes many adverse effects like heating, due to the power factor correction capacitor banks amplification of harmonics , decrease in transmission system efficiency, overheating in distribution transformers, electronic equipment may get fail to function, spurious operation of circuit breakers and relays, errors of measuring instruments, interference with the communication system and controller etc. The grid-interfacing inverter can be utilize to perform following important functions: i) transfer of active power from the renewable resources (wind, solar, etc.); ii) current harmonics compensation at PCC ; iii) load reactive power demand; and at last (iv) current unbalance and neutral current compensation in case of 3-phase 3-wire system. With these sufficient control of grid-interfacing inverter, all the objectives may be achieved either individually or simultaneously.

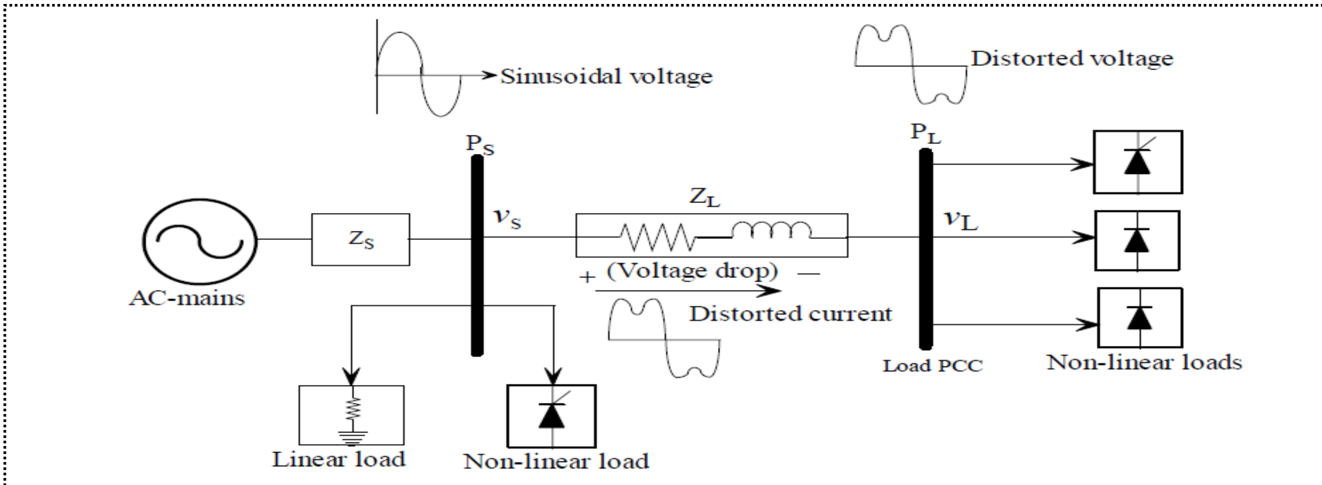

Figure-1. Harmonic voltage distortion at load PCC.

Therefore, the power quality issues have become important now-a-days. The DG-grid interfaced system with power electronics helps to enhance the power quality problems at PCC. Figure-2 it shows block diagram of DG-grid system with power electronics interface which are subdivided into four major sections of power electronics . These include: the AC-DC converter, DC-AC inverter, the output interface and the controller modules.

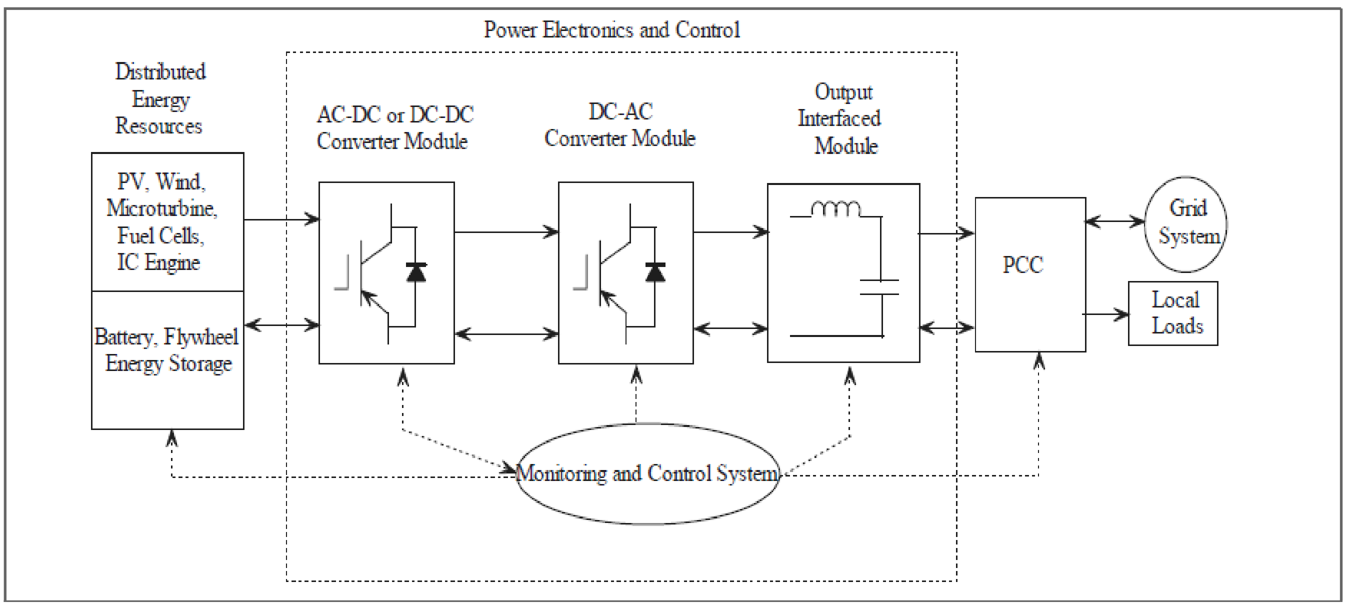

Figure 2: showing the block diagram of D G-grid system with power electronics interface

The unidirectional arrow point toward the flow path of power for the distributed energy sources. Whereas the bidirectional arrows indicate the bidirectional flow of power for the distributed energy storages. The input converter module can be used with alternating current (AC) or direct current (DC) DG systems and it is most likely to be specific type of energy source or storage. The DC-AC inverter module is the most generic of the modules and converts the DC source into grid-compatible AC power. The 4th main module is the monitoring and control module that drives the entire interface and contains protection for both the DG source and the utility at the PCC.

By reference of [13] the power control method for a grid-connected VSI can achieves good (*P*, *Q*) decoupling and fast response. Although, this viewpoint requires knowledge of value in power system equivalent impedance, which is not feasible. Another reference [14] has presente a different power control strategy based on on frequency and voltage droop characteristics of power transmission, which will allows decoupling of P and Q at a steady state. This paper presents the combined operation of DG and APF , which is connected to a dc-link energy storage system through rectifier. The suggested APF system is capable for simultaneously compensating the harmonics, reactive current and also for injecting energy generated by DG system to grid.

II. ACTIVE POWER FILTER

Active power filters are power electronic devices that cancel out unwanted harmonic currents by injecting the compensation current which can cancels harmonics in the line current. Shunt active power filters will compensate load current harmonics by injecting equal-but opposite harmonic compensating current. Generally, three-wire APFs have been conceived by using 3 leg converters. In this paper, it is shown that using an adequate control strategy, even with a three phase 3-wire system, topology of the investigated APF and its interconnection with the grid is presented in Fig.3.

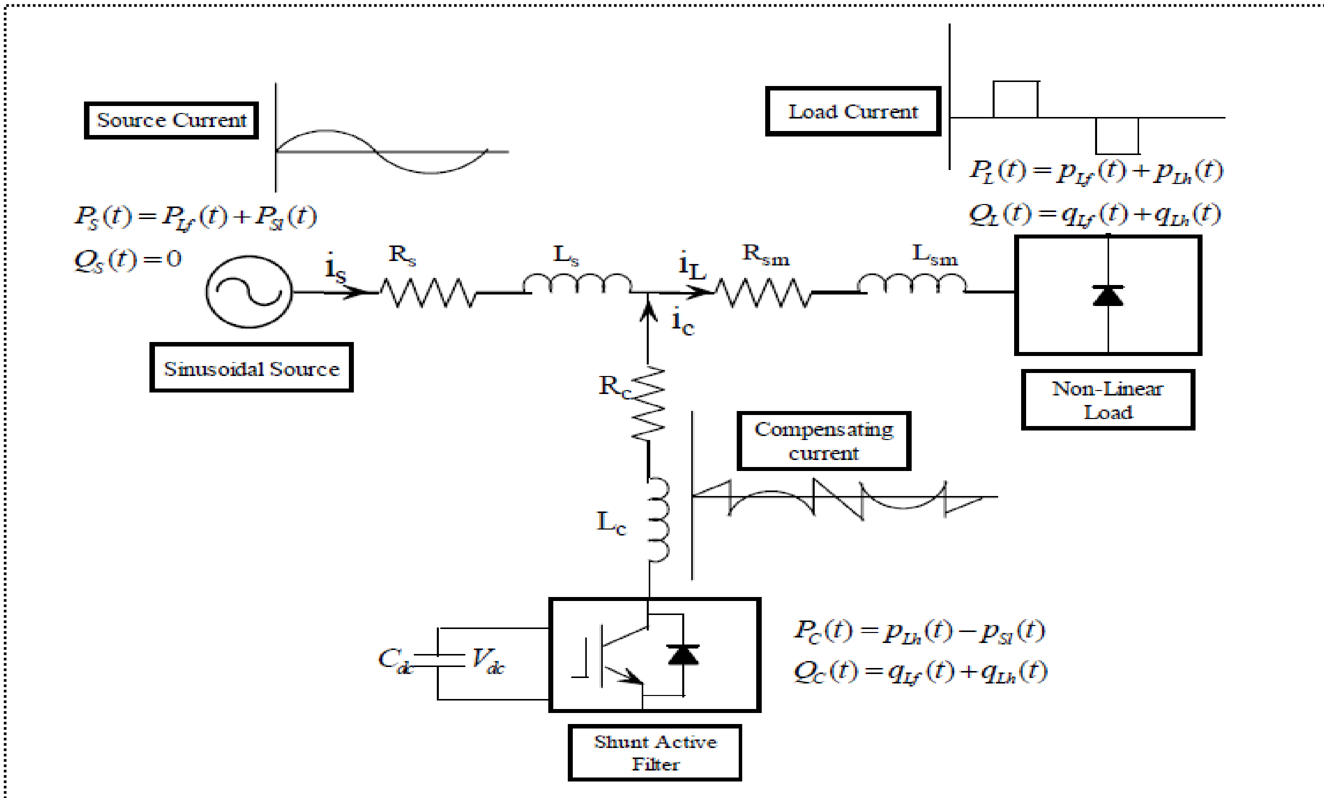

Figure 3: Basic circuit topology of active power filter

$$P_L(t)= v_s(t)i_L(t)$$
$$=V_mI_1\sin^2(\omega t)\cos(\Phi_1)+V_mI_1\sin(\omega t)\cos(\omega t)\sin(\Phi_1)$$
$$+V_m\sin(\omega t)\sum_{h=2}^{\infty} I_h \sin(h\omega t+\Phi_h)$$
$$=P_{lf}(t)+P_{Lq}(t)+P_{Lh}(t)$$

The first term $p_{Lf}(t)$ is the instantaneous load fundamental power. The second term which is $p_{Lq}(t)$ is instantaneous load the fundamental quadrature (reactive) power and the third term which is $p_{Lh}(t)$ is the instantaneous load harmonic power. A shunt APF is designed which is connected in parallel with the load so as to detect its harmonic and reactive current and to inject into the system a compensating current, identical with the load harmonic and reactive current. Thus, instantaneous supply current i_s have only fundamental component which is in-phase with source voltage $v_s(t)$.

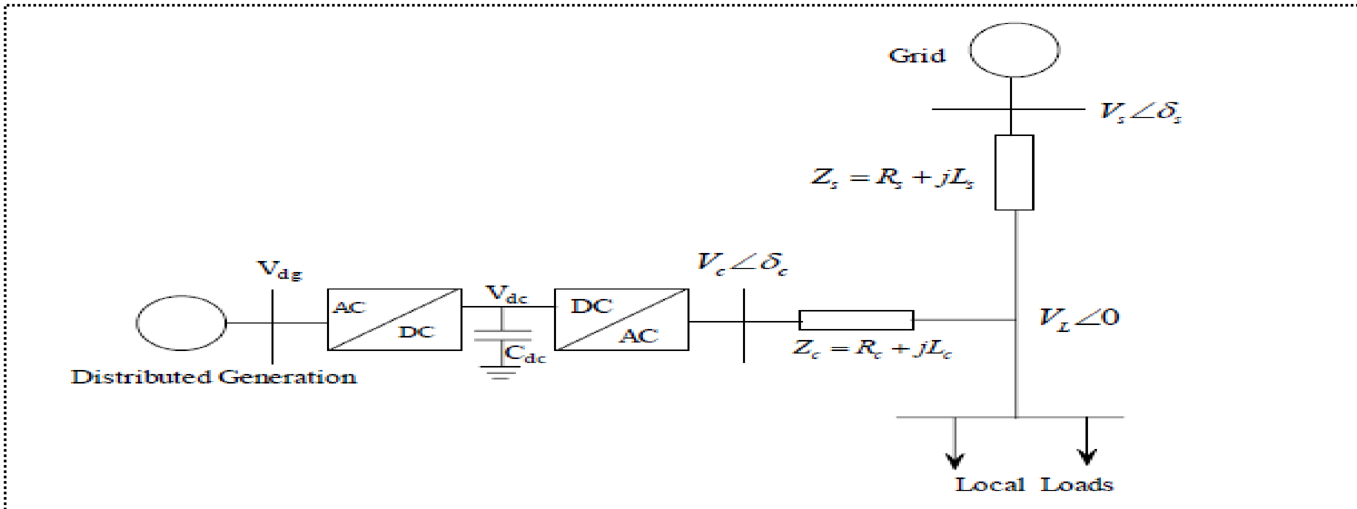

Figure 4 The single line diagram of the DG-grid system

The single line diagram of the DG-grid system representing a 3- phase, symmetrical, balanced steady state system is shown in Figure-6. The active and reactive power (*Pcp*, *Qcp*) transfer between the inverter and the grid system are given by the (5)-(6). The active power transfer is the function of power angle δc and the reactive power transfer is the function of voltage magnitude difference between the inverter voltages and the grid voltages.

$P_{cp}=(V_L V_C \sin\delta_c / \omega L_c)$

$Q_{cq}= (V_C-V_L\cos\delta_c)\ V_C/ \omega L_c$

Where *V*L and *V*C are the load and DC-AC converter (AC side) voltages and δc is the phase angle between them. The reference current of APF is function of active power flow between inverter and PCC.

III.SIMULINK RESULTS

In this paper the we are going to compare the DG system and its performance without APF and with APF. The source voltage, source current, non-linear load voltage, non-linear load current with and without APF are compared. The overall system model containing the power source, without APF and the nonlinear loads are shown in figure5.

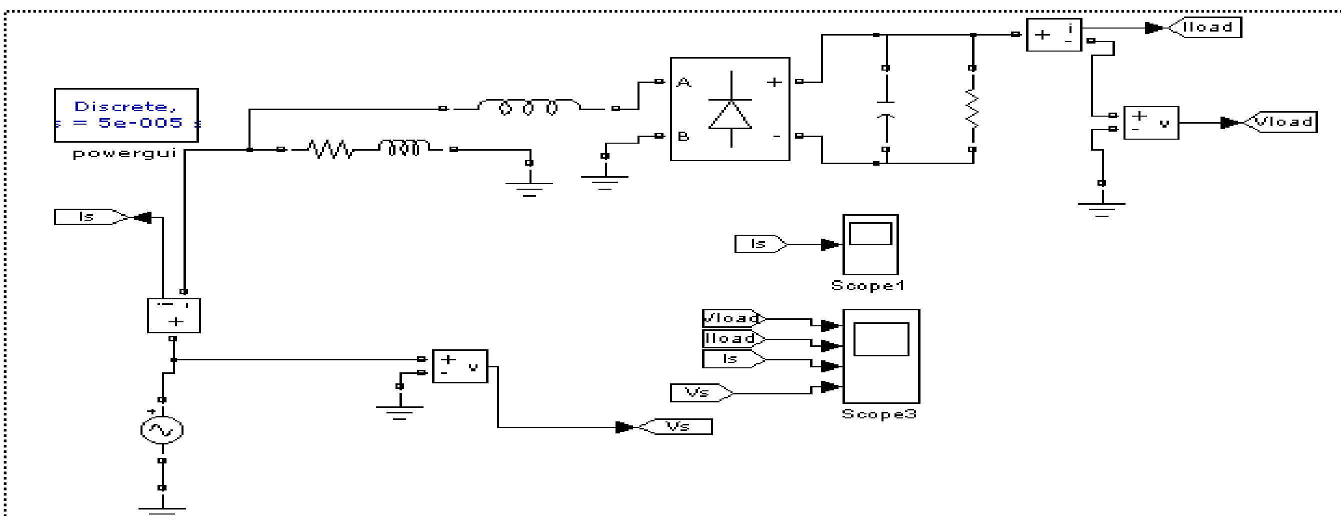

Figure5. DG system without the APF

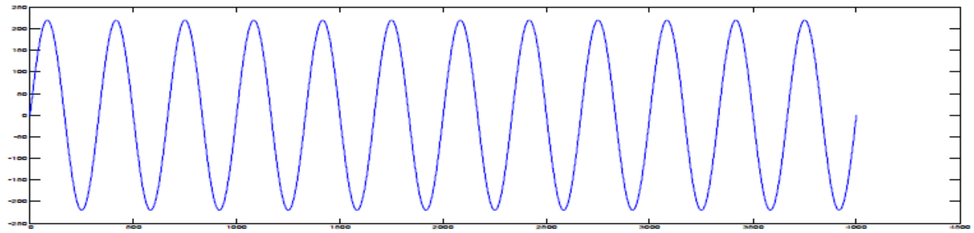

Figure 6: V source without APF

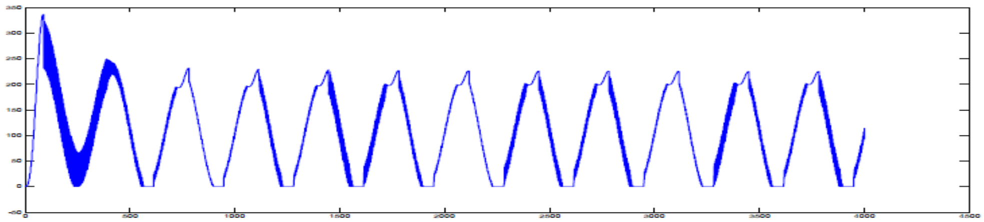

Figure 7: V load without APF

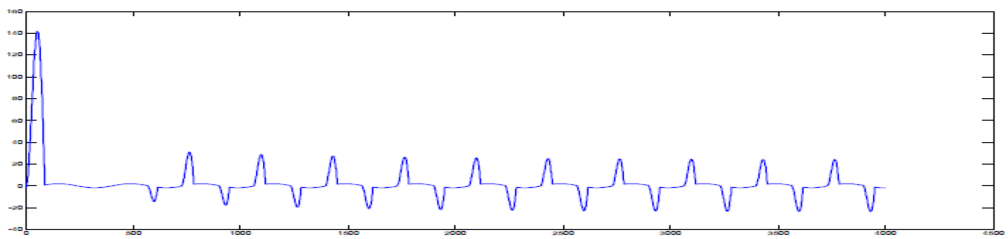

Figure 8: I source without APF

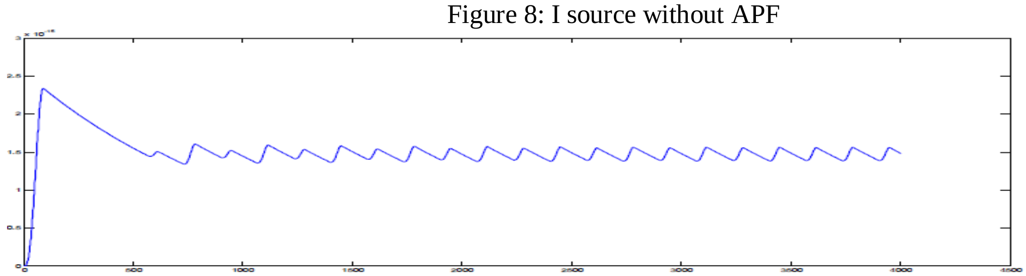

Figure9: I load without APF

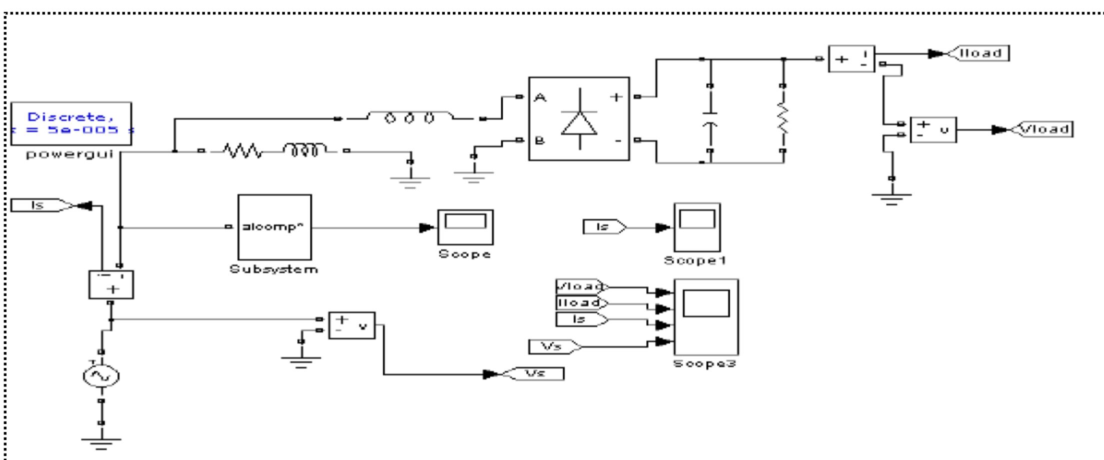

Figure10: DG system connected with APF

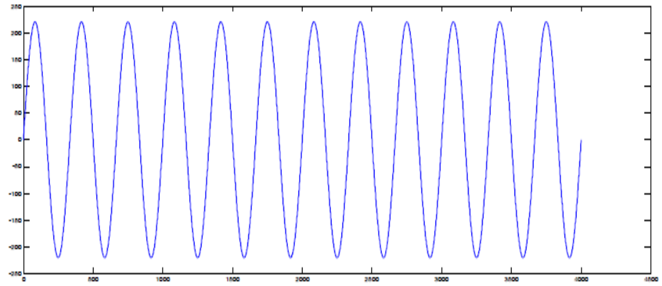

Figure11: Vload with APF

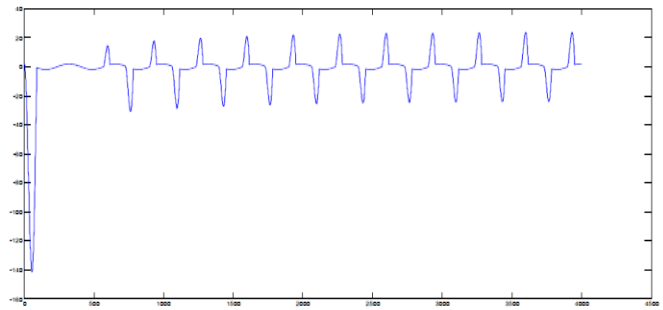

Figure12: Vload with APF

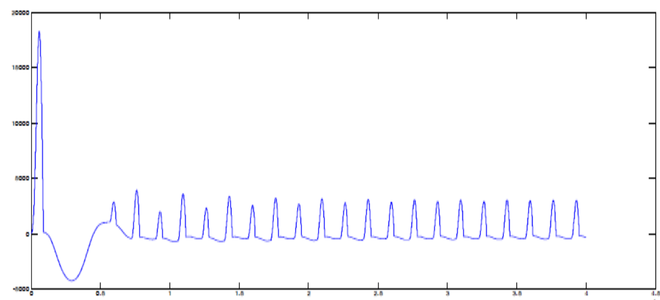

Figure13: Active Power

The figures 10,11,12,13 shows that grid connected single-phase inverter can injects active power into the grid and is able to compensate the local load the reactive power and also local load current harmonics.

IV. CONCLUSIONS

This paper deals with a single-phase APF for DG systems, requiring power quality features as harmonic and reactive power compensation for grid-connected operation. The proposed control scheme may employs a control scheme which is based on the usage of only one LP filter. The grid connected in single-phase inverter will injects active power into the grid and is able to compensate the load reactive power and also the local load current harmonics.

Results have been obtained by simulation/MATLAB which include load reactive power compensation, active power generation and load current harmonic compensation. The integration of power quality features which has the drawback that in the inverter which will also deliver the harmonic compensative current, with the direct consequence of increasing the inverter's overall current and cost. A current limitation strategy to be implemented current margin; this can be used for the compensation of nonlinear load current harmonics and reactive power. If the inverters output current exceeds the switch rating , then supplied harmonic current should be reduced. An analysis of inverter design that can takes into account the current required for reactive power and current harmonics compensation are beyond the paper scope and it is subject of future study.

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