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AN IMPROVEMENT SVPWM BASED SHUNT ACTIVE POWER FILTER FOR COMPENSATION OF POWER SYSTEM HARMONICS

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Abstract: In this research paper, I want to recognize that, Power quality of any system is define mainly three physical Characteristics like frequency, voltage, current and The Power quality problem is defined as "any Occurrence established in current, Voltage, or frequency deviation that outcome in damage, end-used equipment is failure. The maim characteristic of power devices, that they shows the non-linearity things of the devices are mostly responsible for the power quality problems. So, via my research work, I want to solve these problem and to improve the power quality is being given to the development of involving high frequency switching device also to study the harmonics limitation standards for voltage and current waveforms for various utility purpose given by IEEE standards. To all things is control mathematically analysis of the active filters based on different control methods p-q method and id-iq method. To design control circuit of the id-iq control method based on MATLAB simulation circuits find the output by the simulation circuits. This paper is basic study on the Id-Iq scheme based on shunt active filter is brought out in this project. The main purpose of this paper is to study the power quality issues arising due to increasing number of non-linear loads

Keywords: SVPWM (Static Vector Pulse width Modulation), APF (active power filter), PQ active controller, current scheme control, compensation of harmonics.

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INTRODUCTION

Power electronics is now day's very important technology. Mostly power electronics equipment's are used for industry and people daily lives are coming out. In the power grid power electronics produce serious harmonic problems. These harmonic components causes major issues. Harmonic content is an important induct or of the power quality in the power system. The main aim of this paper is to reduce the harmonics level and compensate the harmonics in power system. Increase the value of harmonics compensation the active Power filter plays an important role. APF (active power filter) basically fed on linearization and unified model-ling. In the power electronics converters which is convert the source of voltage and current harmonics. For better use & illuminate this problem, an Active power filter is a type of filter which is grid connected power converter filters, Which has develop mitigate the effects of non-linear loads. The shunt active filter is one such device is designed to inject the current harmonics into the distribution grid, which is used to exactly cancel the polluting currents caused by disturbing nonlinear loads. In the utility power non-sinusoidal current results many problems such as low power factor, low energy efficiency, Electromagnetic interference, Distortion of line voltage etc. In the shunt active filter there are many control strategy like PI, PID and Fuggy controller are developed. The absence of harmonics in the power lines the output is greater power losses in the distribution, causes of noise problems disturb the communication system, also failure of operation of electronics equipment. These equipment have higher sensitive because it is connected with the inclusion of micro electronic control system and their power is very low so these device little noise can be significant. This is the reason which generate the power quality issue. The data
of international standards concern that electrical energy consumption impose the electrical equipment. These equipment should not create harmonics contents greater than specified value. Totally the harmonics is solved by these device which is already installed in the device. Interaction between the passive filter and other loads and its result is unpredictable. So the result of passive filter perform for harmonic reduction are ineffective. Under the specified condition it is proved that active filters are most effective solution
. These filters are able to compensate not only harmonics but also minimize the asymmetric currents caused by non-linear and unbalanced loads. In the last two years due to remarkable progress in the field of power electronics device with forced commutation active filters extensively studied. There are large no of works have published at active filters.

SHUNT ACTIVE POWER FILTER TOPOLOGY:

The main work on active power filter is shunt active power filter. This is show in the Fig 1.2.In this topology there are two level is consists VSI coupled with DC capacitor which is connected in shunt to the non-linear load it is common coupling (PCC) through a ripple factor. In this fig Vsa, Vsb, Vsc represent the source voltage of this topology. In the load current drawn by non-linear load current is denoted by ila, ilb,ilc. Where source current and active filter current is represented as isa, isb, isc, and ifa, ifb, ifc respectively. In the dc side capacitor C is the energy storage element which maintain the dc bus.

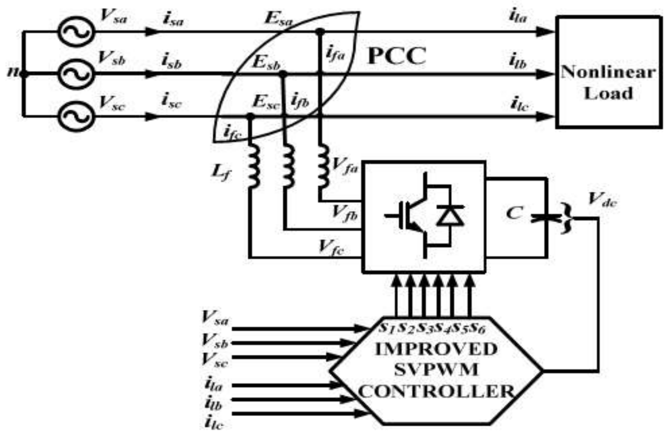

Fig 1.1 configuration of improved SVPWM based shunt APF

Vdc is constant voltage. The recompense signals are generated based on the improved of SVPWM based controller.

Compensation currents of APF are:

ifa= ila – isa

ifb= ilb –isb

ifc= ilc – isc

The voltage-source PWM inverter is a current controller device it easily able to control the harmonics currents. Steady state and transient states both case the control circuits should extract the harmonics current from the non-linear load. For three phase APF initially reactive power theory (IRPT) also it called p-q theory or the synchronous reference frame and synchronous reference frame theory (SRF) theory is generally applied for minimize the necessary compensation signals, and use pulse width modulation (PWM) techniques for gating signals. In the proposed work the all types of theory like shunt APF technology, SRF theory are used to minimize the harmonics current extraction and also SVPWM techniques is used to generate the switching signals. In the SVPWM does not require the triangle waveform generation circuits it is more suitable for relation in digital signal control circuits. The phase-A voltage source and current source is respectively Vsa, & isa and Rs and Ls is the internal source resistance and inductance Esa is the instantaneous voltage of phase A at PCC.

The APF phase - A voltage, current and inductance is respectively Vfa, ifa &Lf is nonlinear load current. These network is define the following equation.

$$V_{fa} = L_f \frac{di_{fa}}{dt} + E_{sa}$$

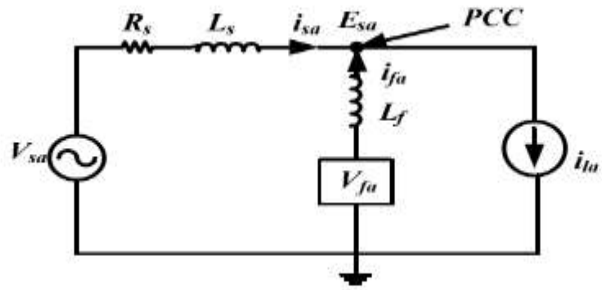

Fig 1.2 Single Phase equivalent circuit of APF

The source current is to be free of harmonics because suitable voltage form of the APF, total harmonics current is emitted from the load is automatically minimized the current. The network is connected with APF through the inductor LF. The main work of Lf is to attenuate high frequency switching and ripple is generated by APF. To connect two Ac voltage source of the inverter and supply system.

ACTIVE POWER FILTER:

Passive L-C filters mainly used to eliminate the harmonics line but the passive filters have many disadvantage like fixed compensation of harmonics, largeness, and also occurs resonance with other element. So recently more advanced method is founded active filter because its result is better than compare to passive filters. The development of active filter easily maturation

Of harmonics. There are many topology of active power filter are used to reduction of harmonics. The shunt active power filters is mainly based on voltage source inverter (VSI) structure it gives enchanting solution to harmonic current problems. The shunt active filter (APF) is a pulse width modulated (PWM) voltage source invert-er it is connected in parallel with load. It has more capacity to inject the harmonic current into ac system with the same amplitude but load phase is opposite. The shunt active filter compensate the load harmonics current its output is show on the load terminal of harmonic current. VSI is the main component of the APF, it is a DC energy device but here it is used like a capacitor and associated control circuits. The active filter performance is depend on the technique which is used to compute the reference current and control method is used to desired compensation current into the line.

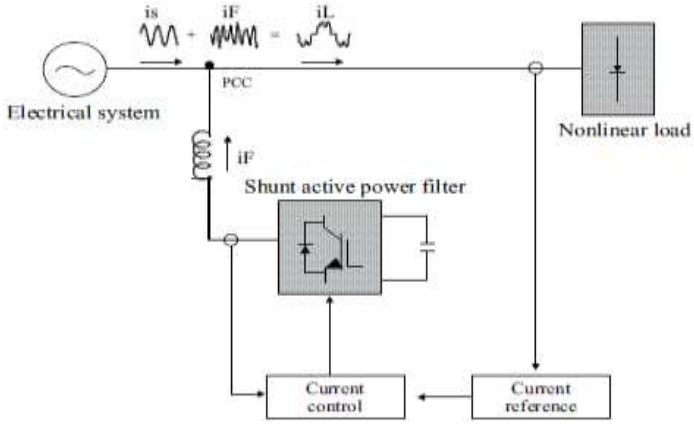

Fig 1. 2 Circuit Diagram of active Power Filter

THREE-PHASE 3-WIRE SAPF TOPOLOGY:

Instantaneous real active and reactive power method: The three-phase, 3-wire shunt active power filter basic block diagram is shown in Fig-1.3 In the non-linear loads is connected with always generates current harmonics.

The reason of harmonics currents, distorted waveform is appeared at the point of common coupling. So for getting sinusoidal waveform to connect the shunt active power filter at point of common coupling. In these shunt active power filters exists of LF filter and voltage source converter. In voltage source converter which is having six controllable switches in connected with parallel with the diodes. The shunt active power filter gives the harmonics currents information from the non-linear load. It also give the information to the PWM circuits. The PWM circuits generates the gating signals to the voltage source inverter. Voltage source inverter switches are operate according to the generation of gating signals.

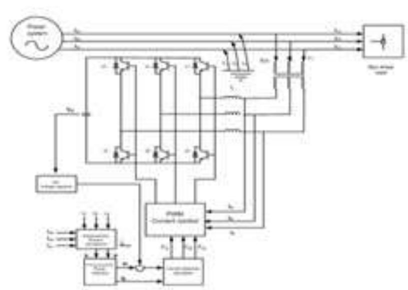

Fig 1.3 The basic block diagram of three phase three wire system

Voltage source inverter output is passing through the LF filters. These Lf filter is mainly used to add the reference signals in phase its opposition the actual current harmonics generated by the non-linear load. The shunt active power filter is operated with the help of real and reactive power control strategy.

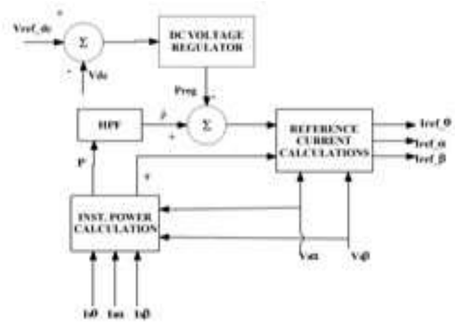

Fig 1.3.1 Active filter controller block diagram

The block diagram of active filter controller is show the operation of real and reactive power control strategy. In this time the calculation of power flows are significant from the average power and root mean square value of voltages and currents. Akagi H proposed a method for calculating reference compensation currents called the instantaneous P-Q method (i.e., instantaneous real active and reactive power theory). These compensation currents are required to inject into the network, and non-linear loads. This P-Q theory depends on time area investigation. By utilizing of this P-Q hypothesis, data of both load line streams and source voltages converters α-βcoordinates with the assistance of quick power. So the P-Q hypothesis has been utilized the change called Clarke change. It is utilized to plot the three stage supply/source quick voltages and yield/stack line streams into α-β-0 coordinates. The change lattices C and C^1 for change of Clarke and back change are given individually in conditions. These theory as voltage wave but it is also applicable for current waves. Here “0” represent the zero sequence component of voltage and current wave. Zero sequence component can’t flow in three phase wire system.

$$\begin{pmatrix} P_r \\ Q_r \end{pmatrix} = \begin{pmatrix} V_{in\alpha} & V_{in\beta} \\ V_{in\beta} & -V_{in\alpha} \end{pmatrix} \begin{pmatrix} I_{op\alpha} \\ I_{op\beta} \end{pmatrix}$$

Rearranging equation (5)

$$\begin{pmatrix} I_{op\alpha} \\ I_{op\beta} \end{pmatrix} = \frac{1}{V_{in\alpha}^2 + V_{in\beta}^2} \begin{pmatrix} V_{in\alpha} & V_{in\beta} \\ V_{in\beta} & -V_{in\alpha} \end{pmatrix} \begin{pmatrix} P_r \\ Q_r \end{pmatrix}$$

$$P_r = \overline{P}_r + \overline{P}_r$$

$$Q_r = \bar{Q}_r + \tilde{Q}_r$$

In these equation are eliminated and the α-β transforming into three phase balanced- linear system. Here Pr is represent the real power it is the sum of average and oscillating real power and Qr is the imaginary Power it is the sum of average and oscillation reactive powers. For linear load Pr and Qr is used only DC/constant/average value. If be used a bridge rectifier with non-linear load, the current waveform should enclose only the 50 HZ/ fundamental frequency component. So the instantaneous Pr and Qr should include constant dc or average component and fluctuating oscillating component as decomposing. The normal part of unaffected Pr and reactive Qr can't to exist as reference powers so that convincing segments of unaffected Pr and imaginary power Qr must need to picked as reference forces, if the shunt dynamic power network is think for compensation current sounds or revolving stream.

SPACE VECTOR PULSE WIDTH MODULATION

The essential thought of voltage space vector modulation is to control the inverter output voltages so that their Parks transform will be around equivalents the reference current vector. On account of two level inverter, the output of each stage will be either +Vdc/2 or – Vdc/2. The SVM method can be naturally reached out to all adjusted and uneven burdens. Space-vector PWM techniques by and large have the accompanying elements: great use of dc-connection voltage, low current swell, and generally simple reproduction execution by an advanced signals processor (DSP). These elements make it reasonable for high-voltage high-control applications. As the quantity of levels increments, repetitive exchanging states and the intricacy of choosing exchanging states increments significantly changes.

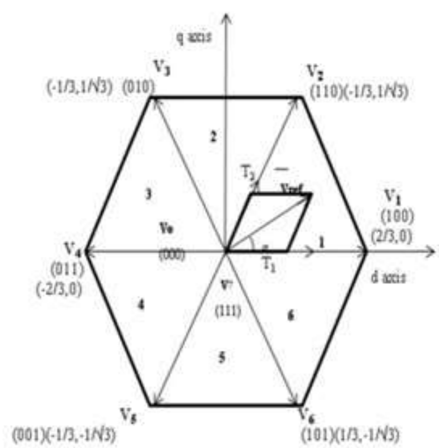

Fig 1.4 SPWM Modulation

IMPROVED SVPWM ALGORITHM FOR APF

The voltage space vector synthetization is a critical part of the conventional for SVPWM. In this method be used a Clarke transformation to transform the reference voltages to d-q coordinate in order to generate the reference vectors. Subsequently, the reference vectors are synthesized by some optimally selected basic vector with specified time duration. The sectors of reference vectors is determined by their phase angle and the time duration of basis vector which is calculated by the computation of phase angle and reference vectors. In the computations there are huge quantities of irrational number and use trigonometric function, so total computation burden is be huge. These operation occurs error about a major problem in calculation which would corrupt the performance of shunt APF. So to solve these errors computational problem, an effective time concept based SPWM is used to generate the switching signals. It is possible in the SPWM to easily reconstruct the actual gating time without separation and recombination effort.

CONSTRUCTION OF PI CONTROLLER

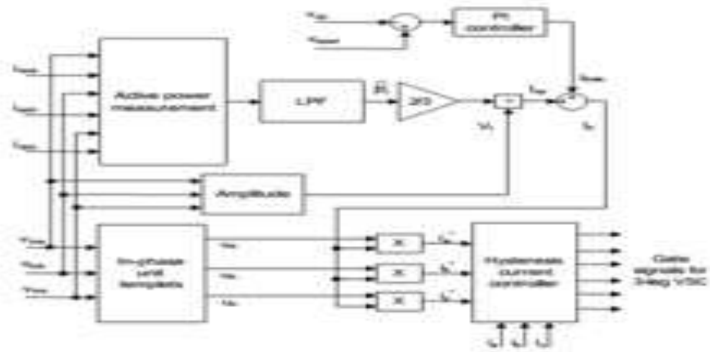

Fig 1.5 Block Diagram of PI Controller

The above Fig 1.6 proves that PWM control circuit of shunt active power network in view of period of current references contains dynamic power estimation, PI – controller, low pass network, reference current generator and hysteresis (Iopa, Iopb, Iopc), the voltages at purpose of coupling (Vina,Vinb,Vinc) and DC interface voltage Vdc are detected signals, and these are utilized as input signs. The greater current references are getting thus of modifiable the dc connect voltage. The error signals is gotten from contrasting the unaffected dc connect voltage and Vref_dc (reference DC voltage). The DC voltage bus error is given as

Here the PI – controller is utilized for DC bus control. So when the error signal is streaming by the method for PI controller, its controls the DC transport current signals, which will give the more prominent estimation of supply current included with the controller and is in this way made open at zero intersection as it were. The output value of the PI controller is more important estimation of supply current that is the characterized into of two components/parts. Those are Essential component/part of dynamic output/load current of SHAF and Trouble component/element of dynamic output/load current of SHAF.

The more important estimation of the current is increase with sinusoidal waveform in step with input/source voltage to get Repaying reference current waves. These repaying reference wave streams contrasted and the assistance of open current waves in the hysteresis band, which will give the slipup signal to the pull strategy. At that point this blunder signal will pick the activity of voltage source inverter switches, these are produces the reference works torrents infused with the assistance of voltage source inverter.

RESULTS:

Mode 1: When PI Controller is off condition, unbalanced load open and Rectifier load open.

The graph is show initial Voltage is constant for some time and suddenly increase the voltage and show the harmonic distortions.

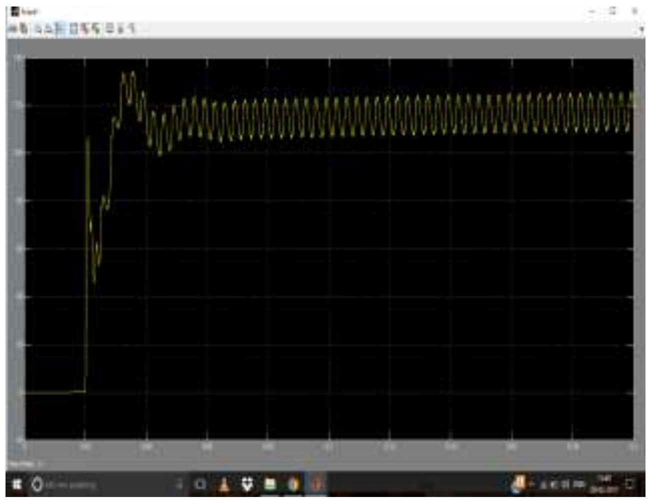

Fig 1.6 Simulation Result 1 when all parameter is open

Mode 2: Rectifier Load connected, PI Controller Open and unbalance load open than.
Here initial voltage is constant for same mode-1 but rectifier load connected show does not harmonics found. Harmonics is zero because it give output dc.

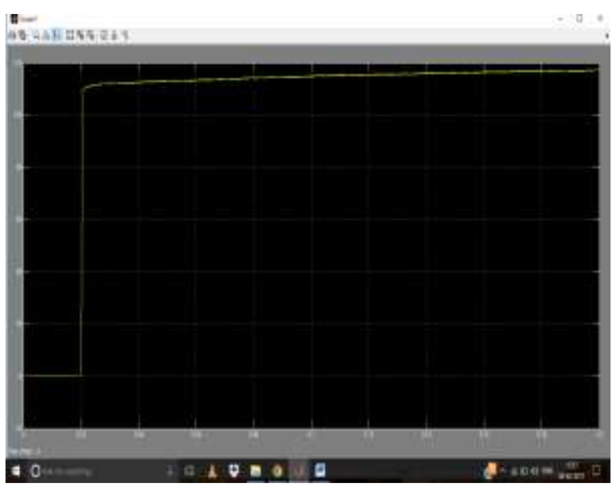

Fig 1.7 Simulation Result When rectifier load connected and all parameter open.

Mode 3: Unbalance Load Connected, PI Controller open, and Rectifier Open
In this mode Voltage constant for 0.02 sec than harmonics introduce, its increase for 0.01sec than decrease at 0.04sec after that harmonics look like sine Wave.

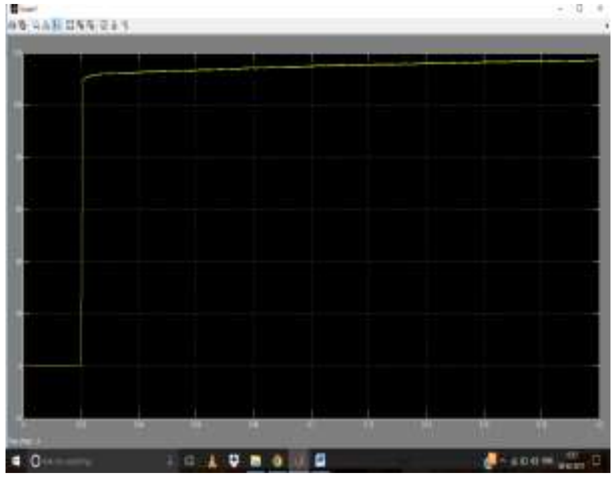

Fig 1.7 Simulation Results when unbalance load connected

Mode 4: When PI Controller and rectifier are connected and unbalance load open.
In this mode harmonics is show before 0.02sec after 0.02sec to 0.04 sec harmonics will be reduce slowly –slowly till 0.06sec after 0.06 sec harmonics is zero and voltage is constant.

Fig 1.8 When rectifier and PI controller is connected

Mode 5: When unbalanced load, rectifier load and PI controller load is closed.
In this mode initial 0.02 sec show harmonics but after 0.02 sec there are no harmonics present in the signals. The voltage will be constant like dc current. This is the effect of PI controller and rectifier when which is closed.

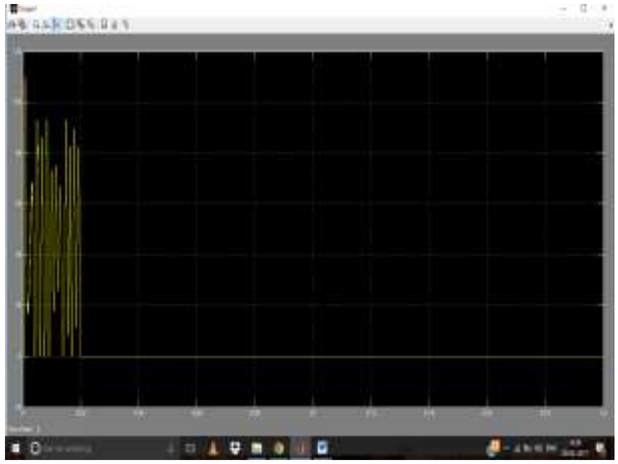
Fig 1.9 When PI controller, unbalanced load, and rectifier connected

CONCLUSIONS:

We have presented the simulations & experimental results of the improvement SVPWM based Shunt Active Power Filter for Compensation of Power System Harmonics. Several tests were performed, in Mat lab simulation, with various parameters is connected and open with source and compare harmonics and used PI controller, rectifier, and non-linear load to reduce the harmonics.

Compare it's in order to obtain experimental results. The experimental results have shown that the SPWM based shunt active power filter to minimize the harmonics and mainly work in this thesis is to reduced harmonics through SVPWM method compare to PWM method because in the SPWM method PI controller is main work. Research and they deserve special thanks. It is a pleasure to convey my gratitude to all of them. First and foremost, I would like to express my deep sense of gratitude and Indebtedness to my

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