Exploration in Power Quality Furtherance on Shunt Active Power Filter

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Abstract- This paper proposes fuzzy and physical phenomenon controllers based mostly 3 phase Shunt Active Power Filter for current harmonic compensation to enhance the performance of 3ϕ provide system feeding non- linear loads. The non linear properties and rapid switching of power electronics components are responsible for the distrubance in the power system. Power quality problems are getting stronger as a result of sensitive instrumentation and are a lot of sensitive for market competition reasons, instrumentation can continue polluting the system a lot and as a result of hike caused by the integral compensation and typically for the shortage of implemented rules. Potency and value area unit thought-about nowadays virtually at constant level. Active power filters are developed over the years to unravel these issues to enhance power quality. Among that shunt active power filter is employed to eliminate and cargo current harmonics and reactive power compensation. During this work mathematical logic controlled, 3 part shunt active power filter to compensate harmonics and reactive power by non linear load to enhance power quality is enforced for 3-phase three wire systems. The advantage of fuzzy management is that it's supported linguistic description and does not require a mathematical model of the system.The compensation method is predicated on sensing line currents solely, associate approach completely different from typical strategies, that need sensing of harmonics or reactive power elements of the load. A MATLAB program has been developed to simulate the system operation. Simulation obtained shows that the performance of fuzzy controller is found to be higher than PI controller. PWM pattern generation relies on carrier less physical phenomenon based current management to get the switch signals to the voltage sourced PWM device.

Keywords – Shunt Active Power Filter (SAPF), Fuzzy Logic Controller (FLC), Hysteresis current controller, Harmonics, Total Harmonic Distortion (THD).

I. INTRODUCTION

In mordern Electrical systems, there has been a outbreak of non-linear loads owing to SMPS,ASDs, Electrical Ballast. Fast advancements within the power electronics technology have resulted in more usage of different electronics devices in industrial, commercial and residential sectors. Electronics items like televisions , computers are included in residential appliances .For business and office equipment like copiers, printers, etc. are used . The industrial area being huge expands its uses with equipments like Programmable Logic Controllers (PLCs), Adjustable Speed Drives (ASDs) , rectifiers , inverters and many more. There is a widespread use of power electronic devices. Hence, the system is observed with harmonics as it consist of non lineear components.

Harmonics causes many issues in operation and client merchandise like heating of the electrical instrumentality, trip of fuse,capacitance injury, eddy current loss, communication interference, impact on electrical device, malfunction of solid state devices and injury of sensitive equipment. Therefore according to IEEE 519 it has become very important to minimize the production of harmonics below 5%.

There are two approaches within the mitigation of power quality issues. The initial approach is of load acquisition in which it is ensured that the power is less sensitive to disturbance , permitting the operation underneath important voltage distortion. While the other approach is to put in line-conditioning systems that suppress or counteract the facility system disturbances. Some of the quality improvement equipment evolve over the years are mounted capacitors, switched capacitance banks, synchronous condensers, static volt-ampere compensators, passive and active power filters etc. Knowing the harmonics of interest and relative invariant with time leads to satisfactory working of passive filters.

However, the passive filter should be tuned to the frequencies of the harmonics to be removed and once the harmonics changes the filter effectiveness is reduced. If multiple harmonics are needed to be removed then the passive filter is forced in multiple stages, increasing its size and price. Passive filters also can turn out harmonics owing to resonance between the filter and supply electrical phenomenon. For overcoming the drawbacks of passive filters and reducing power quality issues variety of attempts are created on the look, analysis and best management development of Active Power Filter (APF). APF may be a power device that may dynamically suppress harmonics and compensate reactive power not with standing the changes of their frequencies and amplitudes. Active filters act as a harmonic attenuation device. The capability and performance of the active power filter is set by the selection of components and therefore the execution of the facility circuit. Dominant the active filter involves creating the selection between open loop and closed-loop system current management. The compensating current needed to be supplied to the network can be calculated on the load side of the active power filter during the open loop mode. In closed-loop system management, the ensuing current within the network is measured and therefore the active filter injects a compensating current so as to attenuate it. The open loop system is less complicated to implement, however economical amount is smaller and need higher accuracy current sensors. The closed-loop system management is additional precise. Thus , the reference current generator and control system becomes the most significant part for the active power filters. Earlier, thyristors, bipolar junction transistors and power MOSFET's were used for active filter fabrication. Later Gate turn off thyristors (GTO's) were used to develop active filters. Recently Insulated Gate Bipolar Transistors (IGBT's) are used for an equivalent.The compensating current is made by a 3 phase IGBT bridge that is controlled by the feedback circuit. The IGBT Bridge uses a dc voltage supply within the sort of a capacitance and therefore the generated voltage is coupled to the provision system through reactor.

II. MODULES STUDY

A. Shunt Active Power Filter –

The shunt-connected active power filter, with a self-controlled dc bus, includes a topology just like that of a static compensator (STATCOM) used for reactive power compensation in power transmission systems. Shunt active power filters compensate the load current harmonics by injecting equal but opposite harmonic compensating current. During this case the shunt active power filter operates as a current supply injecting the harmonic parts generated by the load however phase-shifted by 180°.

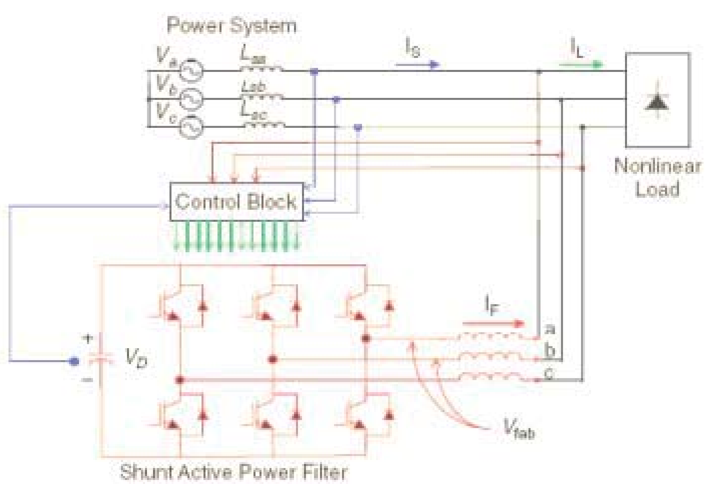

Fig1: Shunt Active power Filter Topology

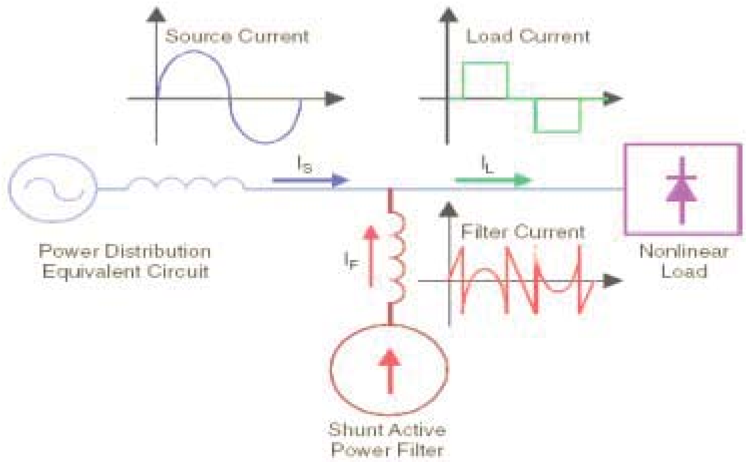

Fig2: Filter current IF generated to compensate load-current harmonics.

Figure 1 shows the connection of a shunt active power filter and Figure 2 shows how the active filter works to compensate the load harmonic currents.

B. ACTIVE POWER FILTERS -

The current harmonics can be resolve using passive filters as the solution , though it has several disadvantages. These disadvantages are namely: they filter solely the frequencies they were antecedently tuned for; their operation can't be restricted to a definite load; resonances can occur attributable to the interaction between the passive filters and alternative masses, with unpredictable results. To return out of these disadvantages, recent efforts are targeted within the development of active filters. Totally different management methods for implementing active filters are developed over the years. One amongst the time domain management methods is the instant reactive power control theory , based mostly on p-q theory . There's another management methodology termed instant active and reactive current element (id-iq) methodology which supportes the synchronous rotating frame derived from the mains voltages without the utilization of phase-locked loop (PLL). And since the p-q theory relies on the time domain, this theory is valid each for steady-state and transient operation, additionally as for generic voltage and current waveforms,permitting the management of APF within the real-time.The solely algebraical operations makes the calculation more simpler proving it more advantageous.

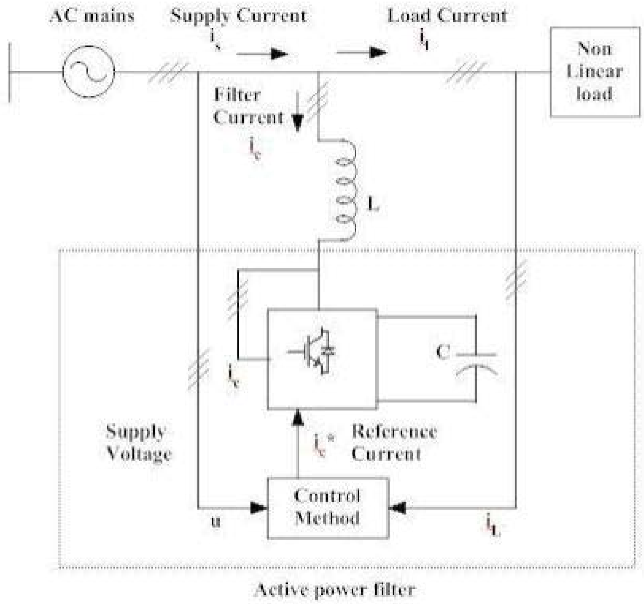

Figure 3: Schematic Diagram of shunt active power filter

C FUZZY CONTROL SCHEME -

The enforced symbolic logic management theme of a shunt active power filter and management technique is as represented in figure 4. So as to implement the management scheme of a shunt active power filter in closed-loop system , the DC facet condenser voltage is detected to compared with a reference value. The obtained error e (V_{dc},ref-V_{dc}) and the modification of error signal ce(n)=e(n)-e(n-1) at the ordinal sampling instant as inputs for the fuzzy process. After a certain limit the fuzzy controller output is assumed same as the refence current (I_{MAX}). This reference current is responsible for system losses and active power demands.

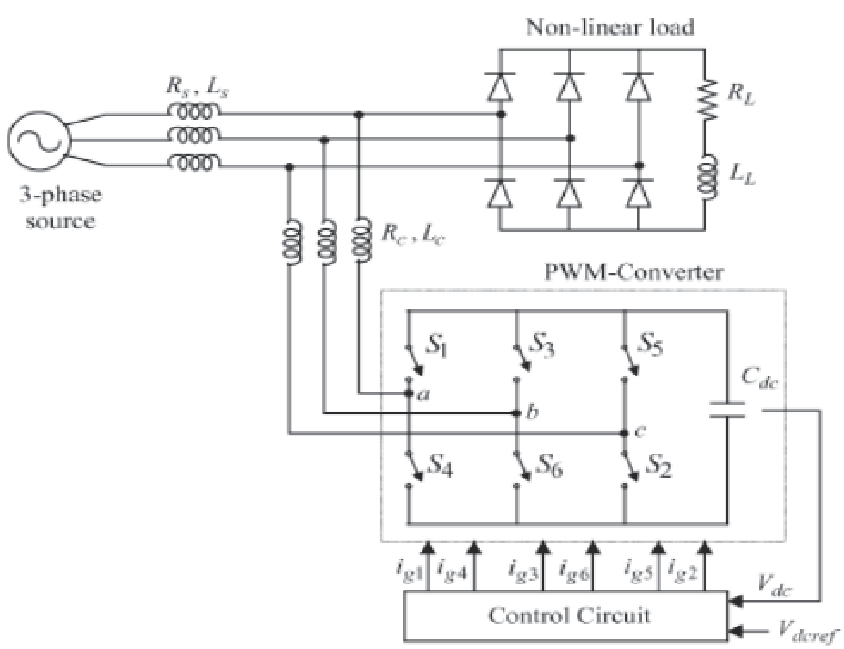

Fig 4: Schematic diagram of closed loop fuzzy logic controlled shunt active power filter.

The shift signals for the PWM convertor ar obtained by examination the particular supply currents (i_{sa}, i_{sb}, and i_{sc}) with the reference current templates (i_{sa} *, i_{sb}*, and i_{sc} *) within the physical phenomenon current controller. shift signals thus obtained, are given to shift devices of the PWM convertor once correct amplification and isolation.

D. PRINCIPLE OF HYSTERESIS BAND CURRENT CONTROLLER -

Hystereris band control is one of the best and simplest technique used for controlling the current in PWM. This technique can be explained in detailed with the help of figure 5.

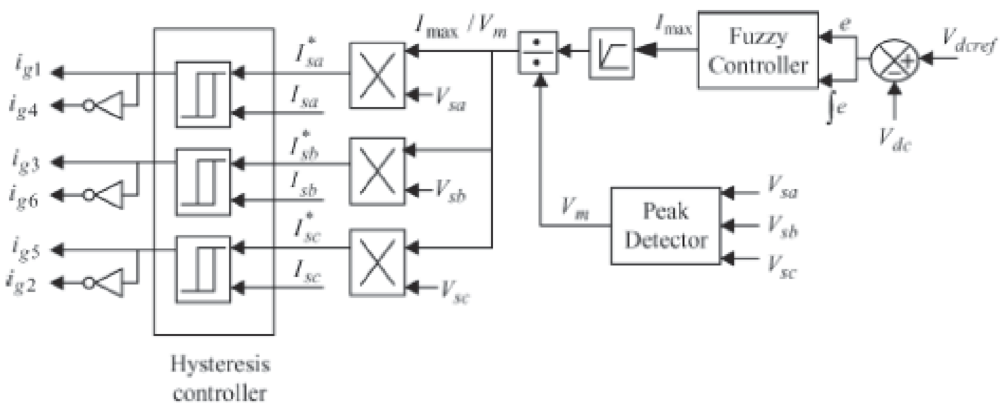

Fig 5: Fuzzy Control scheme

Basically, it's an immediate feedback current management methodology within which the particular current unendingly tracks the command current inside a pre-assigned hysteresis band. The figure 5 shows that, if the actual current exceeds the HB, the upper device of the half-bridge is turned off and therefore the lower device is turned on. Because the current decays and crosses the lower band, the lower device is turned off and therefore the higher device is turned on. If the HB is reduced, the harmonic quality of the wave can improve, however the switch frequency can increase, which can successively cause higher switch losses. This same logic is applicable for 3 phase system waveforms too.the desired output is obtained with the usage of 3 reference singnals of 3 phase system with 120^0 phase shift. This 3 reference singnals are compared with the load current for obtaining the required output.

Various advantages and disadvantages can be stated for this methodology. These are as discussed below:

ADVANTAGES:

1. Excellent dynamic response.
2. Low cost and easily implementation.

DISADVANTAGES:

1. Large current ripple in steady state.
2. Variation of switching frequency.
3. No intercommunication between each hysteresis controller of three phases and hence no strategy to generate zero voltage vector.

Hence signal will leave hysteresis band whenever zero vector is turn on.
The modulation process generates sub harmonic Components.

SIMULATION RESULTS OUTPUT OF SOURCE CURRENT WITH DIFFERENT WAVEFORMS

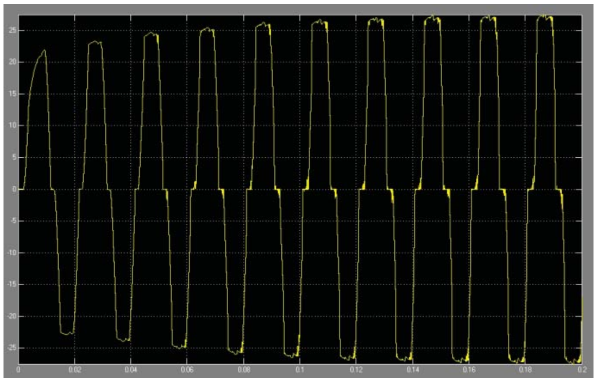

Fig a

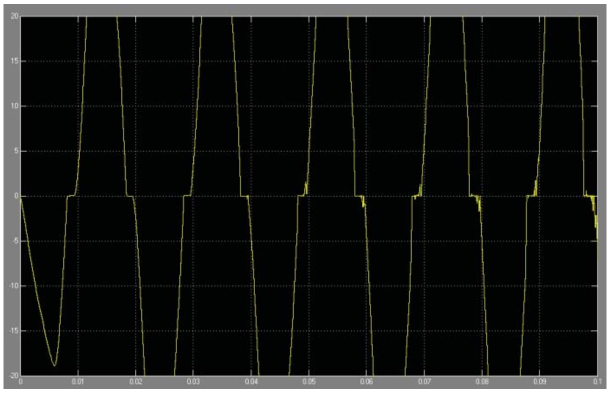

Fig b

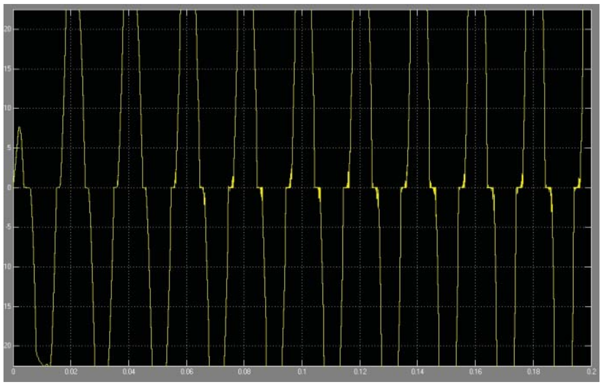

Fig c

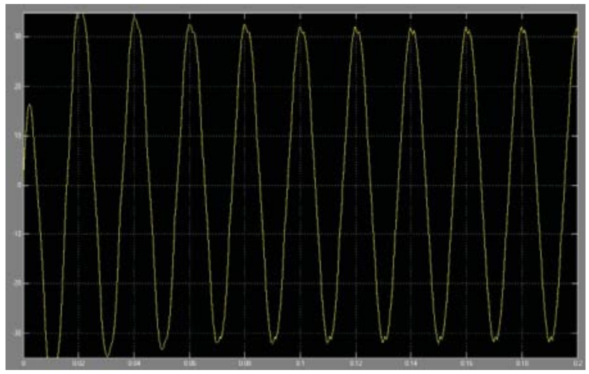

Fig d

IV. CONCLUSION

In recent years, most researchers studied a Shunt Active Power Filters (SAPF) supported typicalntwo-shunt electrical converter with typical controllers that needs a fancy , complex and a sophisticated mathematical model. so as to beat this downside within the literature a physical phenomenon band controller based mostly diode clamped construction electrical converter has been enforced and extended. So my paper deals with the implementation and styling of 3 phase 2 inverters shunt Active Power Filter (APF), in distribution system 11KV to boost the reactive power and then eliminating harmonics from a typical non-linear load, composed from (uncontrolled bridge rectifier with inductive load and DC motor). During this analysis, approximately unity power factor and sinusoidal current supply is obtained. Total harmonic distortion of current source after compensation is found to be 4.35%. However , this THD can be reduced to 2.05% if two inverters are used whic is acceptable as it is less than the limit state by IEEE 519 standard which is 3%. Simulation in MATLAB/SIMULINK using two inverters with 11 step diode clamped multi level inverter is done.

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