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HARMONIC REDUCTION TECHNIQUE USING SHUNT ACTIVE FILTER THROUGH UNIT VECTOR TEMPLATE (UVT) METHOD

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Abstract: Due to use of highly nonlinear device, in the power system harmonics are generated and it decrease the performance of the power systems. Hence it is required to observe and evaluate the different harmonic problems in the power system and introduce the suitable solution techniques. Now a day use of non-linear loads are produced harmonics distortion, to mitigate this distortion the selection of AF (Active Filter) introduce to improve the efficiency of filtering and to solve numerous problems actual with the passive filters. One of the main points for an appropriate application of on AF (active filter) is to apply a improved method for current reference generation system. This paper presents a single-phase shunt active filter (SAF), to achieve current harmonic reduction. For the SAF the control method is based on unit vector template.
Keyword: Power quality, shunt active filter, harmonics, Unit Vector Template, current harmonic mitigation

I. INTRODUCTION

Recently rapidly development of the semiconductor industry, power electronics. In the electronics and electrical industry these power electronics devices have helped, these electronics components are moreover the main cause of power harmonics in the power system. Thus cause of power harmonics are called electrical pollution which will mitigate the power quality of the power supply. As an consequence, filtering process for these harmonics is required in order to improve the PQ of the power supply. Thus, APF appears to be a possible alternative for power conditioning to control the harmonics level in the power system. Now a day electrical Power system harmonics contagion is a very serious and a harmful problem. Usually non-linear loads based on solid-state converters are as UPS, SMPS, etc AF establishes effective proposed solutions than other. AF can solve problem of harmonic and reactive power simultaneously. The electric PQ (power quality) is decreasing generally caused by current and voltage harmonics, negative and zero sequence components, voltage sag, voltage swell, flicker, voltage interruption, etc. Shunt active filter is one among the different types of custom power devices proposed to improve the PQ [1]. Harmonic abstraction process is reference current generated by using the distorted waveform. In this paper present the used shunt active filter technique for power filtering and also studied about the compensation principle used for current harmonics suppression and harmonic control method is applied as it provides an easy and quick response in the system.

II. SHUNT ACTIVE FILTER (SAF)

General block diagram of SAF filter (SAPF) is illustrate in Figure 1, where as the basic overall system block diagram using UVT (Unit Vector Template) method is illustrate in Figure 2 [2]. The SAF is a apparatus that is joined in parallel and cancels the harmonic and reactive currents from a nonlinear load. The entire resulting current drawn from the main ac is sinusoidal waveform. Preferably, the AF (Active Filter) requirements to generate just sufficient harmonic current to compensate the nonlinear loads in the line. An active filter ia a current controlled VSI (voltage source inverter) is used to generate the compensating current and is injected into the main power source line. This compensating current is cancel the harmonic components drawn by the nonlinear load and conserve the main line current (is) sinusoidal. Illustrate in figure 2 the instantaneous current of the nonlinear load is prolonged into 3 expressions. The first is the load Reference currents which created using PLL (Phase Locked Loop).The system control scheme is based on the extraction of UVT from the imprecise input supply. The Unit Vector templates method will be subsequently equivalent to pure sinusoidal signal with unity amplitude. SAF compensate current harmonics by introducing the same as but opposite harmonic compensating current. In this condition the shunt active filter works as a current source injecting the harmonic.

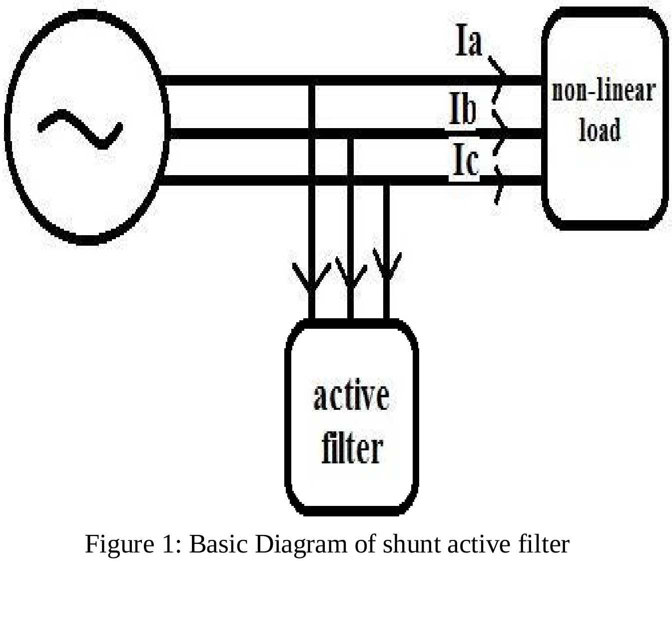

Figure 1: Basic Diagram of shunt active filter

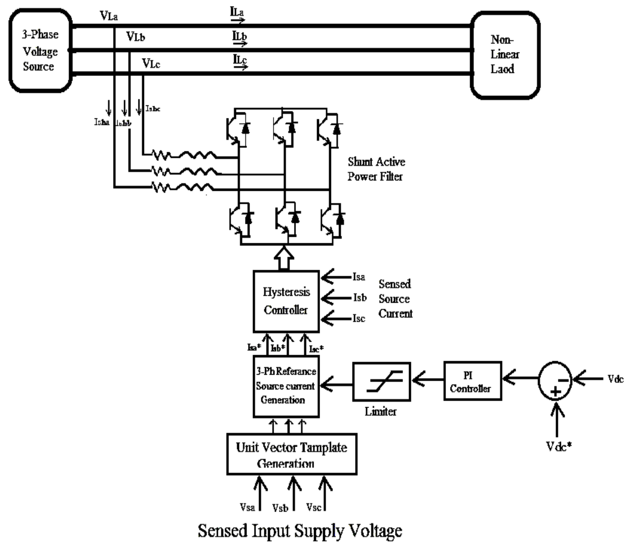

Figure 2 Overall Block Diagram System

III. SHUNT ACTIVE FILTER CONTROL STRATEGY

The control strategy is primarily the way to generate reference signals for Shunt Active Filter. The effectiveness compensation of the SAF depends on its ability to follow with a time delay and least error to calculate the reference signals to compensate the distortions, unbalance currents or voltages or any other unbalance condition [6].Generally different types of control techniques are used in Shunt AF. UVT techniques is used in Shunt AF present in this paper [3,4]. Illustrate in figure 3, the reference current signal is creation for Shunt AF. In this system the PI (Proportional Integral) controller is used to get synchronization with supply voltage. The basic concept of three-phase voltage reference signal for Shunt active filter is based on UVT (unit vector template) is achieved by using Proportional Integral (PI).

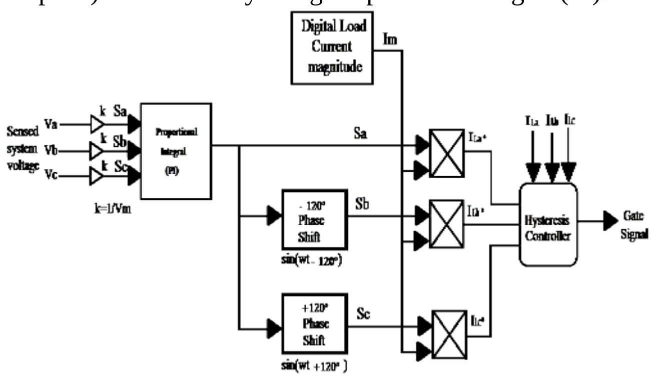

Figure 3 Control Block Diagram of Shunt AF

Subsequent to getting the removal of three-phase voltage reference signal with multiplying the peak amplitude of fundamental input voltage with unit vector template of equation (1) gives the reference load voltage signals which is given by equation:

$$V^{*}Labc = Vm * Sabc \quad \text{....1}$$

The reference load voltage (V*L) and sensed load voltage (VL) are equated in hysteresis controller to generate switching signals to the switches of shunt active filter.

IV. PROPORTIONAL INTEGRAL (PI) CONTROL SCHEME

Illustrate in figure 4 general block diagram of the proposed PI control scheme of an Shunt SAF. In this system the sensed voltage from the system is compared with a reference value and obtained error e=Vdc,ref - Vdc at the nth sampling immediate is used as input for PI controller

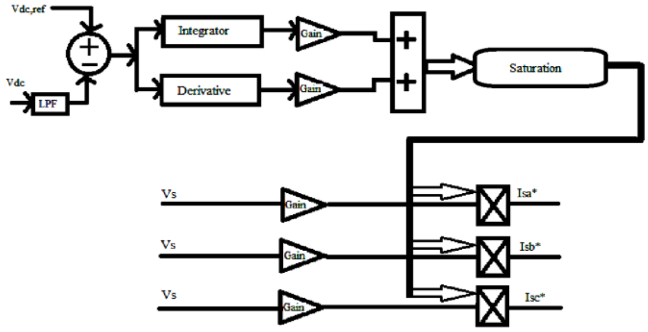

Figure 4 General Block Diagram of PI Controller

Proportional integral controller transfer function can be represented as:

$$H_{(s)}=KP+KI/s \quad \text{....(2)}$$

Where, Kp is the proportional constant that defines the voltage control dynamic response and KI is the integration constant that defines it's settling time. Proportional integral controller to reject the steady state error in dc voltage. In the PI Controller the proportional gain and integral gain are set such way that Vdc is virtually equal to the reference value of Vdc [5].

V. REFERENCE SIGNAL GENERATION AND HYSTERESIS CONTROLLER

Essentially to compensate for current harmonics as well as to maintain the voltage at constant level, the SAF is used. To complete the above task the sensed the voltage and passed through the first-order low pass filter to mitigare the ripples present on the voltage, Vdc, and then after it is compared with the reference voltage [7]. Hence gives the voltage error.

This voltage error is then processed by a discrete PI controller. The output results of the PI controller will be the peak amplitude of fundamental input current, which must be drawn from the supply in order to maintain voltage at constant level. Illustrate in figure 5 the peak amplitude, is then multiplied with UVT giving reference current signals for shunt active filter.

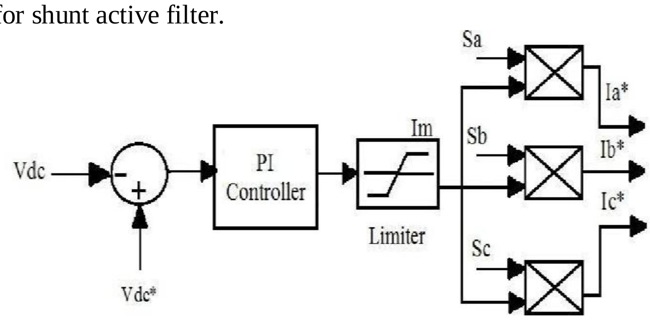

Figure 5 Reference Current Signal Generations

The instant reference value of three-phase current is calculated as:

$$Ia* = Im - Sa$$
$$Ic* = Im - Sc \qquad ....(3)$$
$$Ib* = Im - Sb$$

After getting the reference current signals for SAF, after that next step is to triggering the inverters to follow these reference signals. This reference signal can be prepared by switching the IGBT's in proper manner. The switching manner have the necessary gating signals, the hysteresis controller is used. The hysteresis current control method is applied to control VSI so that a resultant current is crated which follows a reference current waveform.

In Hysteresis control method, the sensed current is compared with the hysteresis limits and the comparison output is used to control the switching sequence. To determine the current error, the reference current are compared with actual currents by following equation:

Iaerror=Ia*-Ia
Iberror=Ib*-Ib ....(4)
Icerror=Ic*-Ic

Resultant of these current errors is given to hysteresis current controller. Illustrate in figure 6 the hysteresis controller then create the switching pulses for the inverter gate pulses [7].

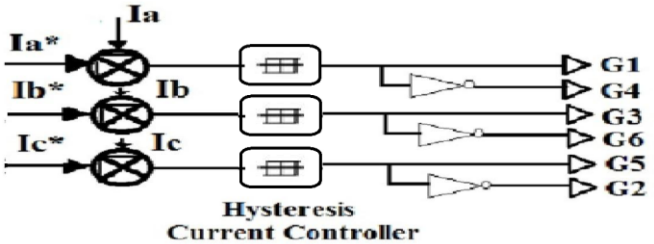

Figure 6 Hysteresis Current Controllers

VI. SIMULATION AND RESULT

The shunt active filter illustrate in figure 7 is a Current controlled VSI, which is joined in shunt filter. Shunt active filter is used to compensate the current related problems. In this simulation system R-L load is connected and FFT analysis has been take out simultaneously.

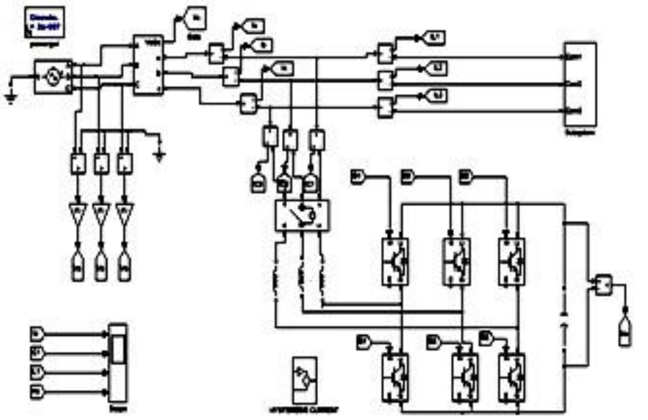

Figure 7 Shunt Active Power Filter Simulink Modal

In this part, the simulation results of MATLAB are presented to show the performance of SAF for current harmonics mitigation based on UVT technique. There is analyzed for SAF based on UVT control technique which is given below. The supply voltage deformation is formed in all three phases by connecting a 5th (20% of the fundamental input supply voltage) and 7th (10% of the fundamental input supply voltage) harmonic voltage source in series with the service voltage. The current harmonics are mostly compensated by SAF is illustrate in figure 8 and 9.

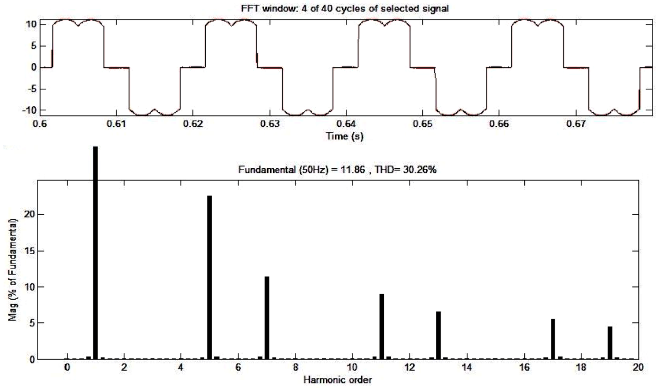

Figure 8 Frequency Spectrum of Load Side

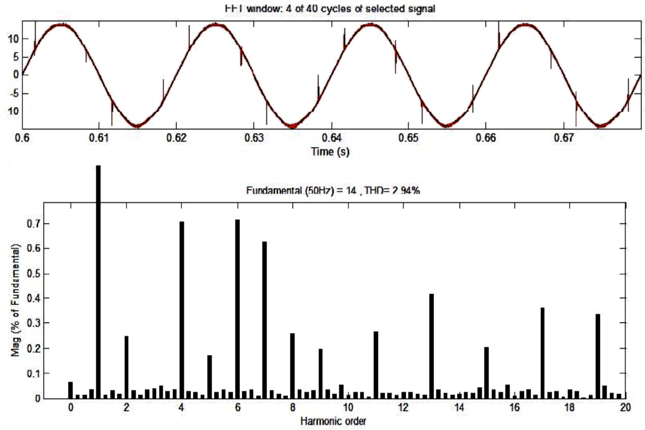

Figure 9 Frequency Spectrum of Source side

For the simulation result of Frequency spectrum of load and source current is shown in Figure 8 and figure 9 respectively during current harmonics condition. By using theory of Unit Vector Template during current harmonics condition the THD of source current is reduced from 30.26% to 2.94%.

VII. CONCUSION

This paper presented on harmonic mitigation technique by using the Shunt AF to improve the electric power quality at distribution level. The Shunt AF is competent to compensate for load current power quality issues like reactive current, unbalance, harmonics and neutral current. In this paper harmonic related problem has discussed using Shunt APF. Here out of the numerous technique the UVT technique better the other. Advantages of UVT method is less calculation, low switching losses, use less memory and very high speed compare other methods. After study the simulation result, THD analysis of current compensation, it is clear that using of the Shunt Active Filter with Unit vector template method reduction of the harmonic is 30.26% to 2.94%. According to IEEE standard THD should be must below 5%, consequently, SAF with Unit Vector Template method is appropriate method to compensate the harmonics.

REFERENCES

[1] Akagi. H, "New Trends in Active Filters for Power Conditioning", IEEE-Transaction on Industrial Applications, vol. 32, No 6, Dec., pp 1312-1322, 1996.
[2] Rama Rao and Dr.Subhransu Sekhar Dash, "Power Quality Enhancement by Unified Power Quality Conditioner Using ANN with Hysteresis Control", International Journal of Computer Applications (0975 – 8887), Volume 6– No.1, September 2010.
[3] V.Khadkikar, A.Chandra, P.Agarwal, A.O.Barry and T.D.Nguyen, "A Simple New Control Technique For Unified Power Quality Conditioner (UPQC)", International Conference on Harmonics and Quality of Power, 2010.
[4] S. Srinath, M.P.Selvan, K.Vinothkumar, "Comparative Evaluation of Performance of Different Control Strategies on UPQC Connected Distribution System", 5th International Conference on Industrial and Information Systems (ICIIS), July 29 -Aug. 01, 2010.
[5] Karuppanan P and Kamala Kanta Mahapatra, "PI, PID and Fuzzy logic controller for Reactive Power and Harmonic Compensation", National Institute of Technology-Rourkela, India-769008
[6] Vadirajacharya. K., Pramod Agrawal, H. O. Gupta, "Control of current-Source Active Power Filter Using Unit Vector Template In Three Phase Four Wire Unbalanced System", PEDS 2007.
[7] S.Premalatha, Dr. Subharansu Sekhar Dash, Panduchuri Chandra Babu, "Power quality improvement features for a distributed generation system using shunt active power filter", ELSEVIER 1877-7058 © 2013 The Authors. Published by Elsevier Ltd., doi:10.10.1016/j.proceng.2013.09.098

