Performance Analysis of Fuzzy Logic Controller based Hybrid Series Active Power Filter working under unbalanced supply condition

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Abstract: In this synopsis a new control algorithm for a Series Hybrid Active Power Filter (SHAPF) is proposed. With the proposed control algorithm, the series active power filter simultaneously compensates for source voltage unbalance and source current harmonics generated by non-linear loads. The proposed control algorithm is based on the generalized instantaneous power theory and Indirect Current Control.

This system is capable to mitigate voltage and current harmonics at low voltage distribution system. The control scheme is designed for absorbing higher order harmonics and stores the same in capacitor and reverts to system in the form of fundamental Waveform thereby filtering action was done.

The reference voltage is directly associated with three- phase instantaneous voltages and currents and are separated in three-phase co-ordinate systems. Therefore, the calculation of the compensation reference voltage is much simpler than the other available control algorithms. It can be applied for both voltage and current harmonic generating loads connected across balanced and unbalanced source voltages. The proposed control algorithm is based on the generalized instantaneous power theory and Indirect Current Control with fuzzy logic controller for Series Hybrid Active Power Filter (SHAPF) tested under unbalanced supply conditions.

I. Introduction

As a rule the majority of the like radiant lighting and air conditioning engines are direct loads, they don't make aggravation source wave forms. However, loads like curve heater, foothold etc. are considered as nonlinear burdens and they basically contort the source wave forms. Additionally If AC power is constrained by utilizing strong state gadgets like diodes or thyristors, the information voltage or potentially current AC wave forms gets mutilated. These strong state gadgets draw music and receptive force from framework. The results of nonlinear burdens are infused sounds, receptive force weight, unbalance and extreme nonpartisan flows cause low framework proficiency and helpless force factor and makes aggravations other close by buyers and obstruction in phone lines.

The overviews as in were completed to register the afflictions related with electric force frameworks having nonlinear burden and uneven burdens. Unadventurous aloof L–C channels were utilized to diminish music and capacitors were utilized to improve the force factor of the air conditioner loads. Notwithstanding, these uninvolved channels are restricted to steady responsive force pay, specific consonant or band with symphonious decrease, enormous r in size, and reverberation with network inductance. There is a requirement for dynamic and precise techniques to alleviate these sounds and to decrease their effects on framework conduct.

In this research work, the performance of the Hybrid Series Active Power Filter (SHAPF) voltage control strategy has been evaluated in terms of harmonic mitigation. This research presents Instantaneous power theory and Indirect Current Control to enhanced performance of Hybrid Series Active Power Filter (SHAPF) for power quality improvement by mitigating the harmonics. For exacting the reference voltages for Hybrid Series Active Power Filter, instantaneous power theory and Indirect Current Control with Fuzzy logic controller can be developed. The proposed Hybrid Series Active Power Filter can be verified through MATLAB/SIMULINK model. This project presents an overview of performance analysis of Fuzzy Logic controller based Hybrid Series Active Power Filter working under unbalanced supply condition. The Fuzzy Logic controller under balanced, unbalanced, non-sinusoidal control has to be validated for Series Hybrid Active Power Filter (SHAPF). Fuzzy logic controller will be made better based on certain performance parameters.

II. RELATD LITERATURE

1) A practical approach to harmonic compensation in power systems-series connection of passive and active filters

The author gives a consolidated framework a detached channel and a little appraised dynamic channel, both associated in arrangement with one another. The inactive channel eliminates load delivered sounds similarly as a customary channel does. The dynamic channel assumes a part in improving the separating qualities of the uninvolved channel. This outcomes in an incredible decrease of the necessary rating of the dynamic channel and in disposing of the apparent multitude of impediments looked by utilizing just the latent channel, prompting a reasonable and practical framework. The dynamic channel has an a lot more modest rating than a customary dynamic channel[1].

2) A review of single-phase improved power quality AC-DC converters Neural Network Toolbox By Using MATLAB 2016

In this paper creator centers around Solid-state switch-mode amendment converters have arrived at a developed level for improving force quality regarding power-factor rectification (PFC), decreased absolute symphonious contortion at input air conditioning mains and unequivocally managed dc yield in buck, support, buck–help and staggered modes with unidirectional and bidirectional force stream. This paper manages a far reaching audit of improved force quality converters (IPQCs) arrangements, control draws near, plan highlights, choice of segments and their appropriateness and choice for explicit applications

3) Comparison of Voltage-Source and Current-Source Shunt Active Power Filters

In this paper creator examine the two dynamic channel geographies are thought about. To start with, the space-vector tweak methods and fundamental circuits are contemplated and the advanced control frameworks are introduced. The sifting execution of the frameworks with various types of burden is introduced lastly the force misfortunes of the channels are analyzed.

4) A DSP-Based Control Algorithm for Series Active Filter for Optimized Compensation Under non sinusoidal and Unbalanced Voltage Conditions

In this paper creator manages expansion of nonlinear burdens in the force framework has prompted the presence of non-sinusoidal voltage wave forms. Asymmetrical conveyance of huge 1-phi stacks further con volutes the issue by causing irregularity in the 3-phi flexibly voltage. Such a gracefully can antagonistically influence the hardware touchy to voltage waveform quality. Thus, voltage pay is attractive[4].

5) A novel control scheme for series hybrid active power filter for mitigating source voltage unbalance and current harmonics.

This paper briefly reviews the performance of the Hybrid Series Active Power Filter (SHAPF) voltage control strategy has been evaluated in terms of harmonic mitigation. This research presents Instantaneous power theory and Indirect Current Control to enhanced performance of Hybrid Series Active Power Filter (SHAPF) for power quality improvement by mitigating the harmonics.

III. The Generation and Harm of Power Harmonic

The Generation and Harm of Power Harmonic The central of symphonious age is caused because of the nonlinear burden. At the point when the current through the heap, the relationship wasn't straight with the voltage applied, the arrangement of non sinusoidal current, bringing about consonant. At the point when source impedance exists in the real framework, the bending current will cause a voltage drop in the impedance, bringing about contortion of the voltage. The responsive force remuneration. Through a specific calculation to identify consonant current in load side need, it gives relating symphonious current, to accomplish the objective of remuneration. It utilizes a specific calculation to distinguish the consonant current which is the heap need, and it gives relating symphonious current, in order to accomplish the objective of pay. Current framework will be near an ideal sine wave after pay. Joined with uninvolved LC channel utilizing half breed dynamic force channel from one viewpoint it can well improve the inactive LC channel sifting impact, then again, it comparative with the different utilization of dynamic channel and its introduced limit is extraordinarily diminished. In this paper, the arrangement crossover dynamic force channel innovation is contemplated. voltage twisting will influence the entirety of the heaps. In the framework the primary consonant source can be separated into two classes. Power electronic gadget contains a semiconductor nonlinear parts of the consonant sources, for example, different rectifier hardware, AC voltage controller, variable current gear, DC drive gear, rectifier, PWM recurrence converter, stage regulation recurrence converter and present day mechanical offices for energy protection and control of intensity electronic hardware, etc. Nonlinear gadget contains electric circular segment and ferromagnetic of the consonant sources, for example, AC electric curve heater, AC Welder, bright lights, generators, transformers and ferromagnetic reverberation hardware, etc. Hence, it is a consonant source which can't be overlooked. These make the twisting of the force framework voltage and current waveform, bringing about a higher consonant. The consonant voltage and symphonious current to the harm of intensity framework can be extensively in the accompanying viewpoints. An enormous number of sounds decrease the proficiency of intensity age, transmission and electrical gear and include extra symphonious loss of components. Harmonics influence the typical activity of different electrical devices. In the force framework consonant will cause fractional equal full and arrangement reverberation, which amplify consonant, increment extra misfortune and fever and cause gadget disappointment. Consonant can result the transfer security and programmed gadget misoperation and make electric estimating instrument estimation inaccurate. Harmonic can create obstruction or commotion on the close by correspondence framework, so it lessens the correspondence quality. There are three primary techniques for symphonious treatment. Before the finish of governance. Starting from the gear or framework impacted by harmonics. Improve their enemy of sticking capacity.

Introduction to Hybrid Series Active Power Filter

With the state of intensity consonant turning out to be increasingly genuine, imperfections of the conventional inactive force channel plot has gotten clear to an ever increasing extent. The majority of the utilizations of dynamic force channels are equal. Shunt dynamic force channels need the gadget with enormous limit, so the venture and activity cost is exceptionally high. This paper proposes half and half arrangement dynamic force channel to diminish consonant. Mixture arrangement dynamic force channel chiefly made out of a little limit of dynamic force channel fell in the force framework and a couple of equal LC aloof force channels. The structure of the framework is appeared in figure 3.As it shows in figure 3, so as to wipe out the vast majority of sounds brought about by the electrical burden, the detached force channels comprise of multiple times, multiple times channels and a high-pass filter.Hybrid arrangement dynamic force channel has the upside of both dynamic force channels and uninvolved force channels, and it can adequately repay music responsive force in high force applications moreover, it can conquer the deficiencies of LC

channels defenseless against influenced by the force framework impedance to reverberate.

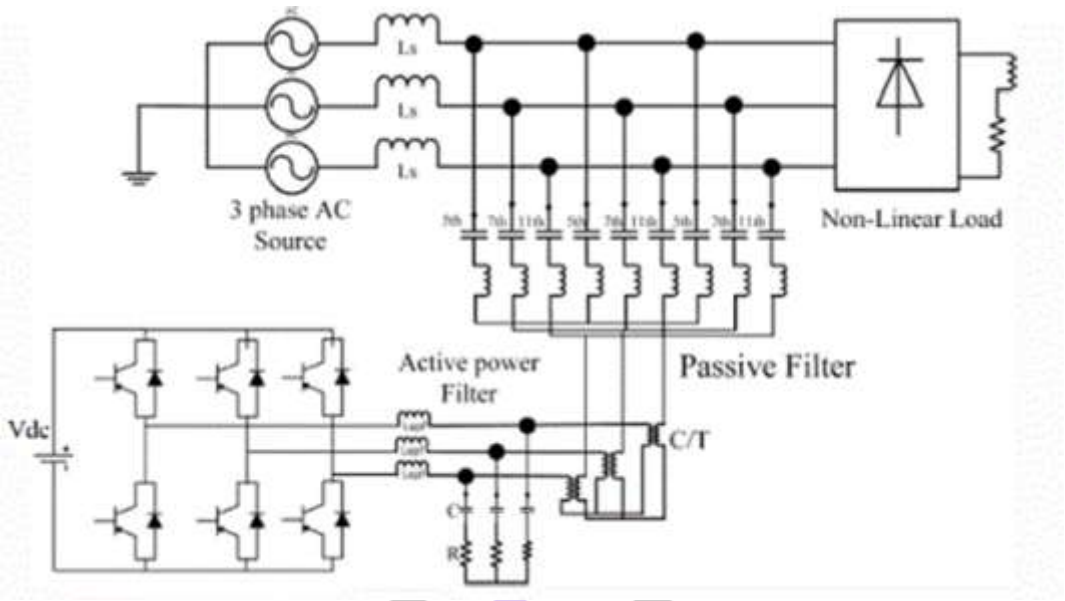

Fig.1.Sereis active power filter topology

Control of a Hybrid Filter Using Indirect Current Control

In this control calculation, the computational deferral and number of sensors are diminished contrasted and the immediate receptive force hypothesis, by in a roundabout way controlling the three-stage gracefully flows. In this half breed channel arrangement flows are detected and their major parts are assessed with a comparable calculation embraced for the dynamic channel controlled utilizing SRF hypothesis. Notwithstanding, rather than load flows, flexibly flows are detected and handled in this calculation.

FUZZY LOGIC CONTROLLER (FLC)

Fuzzy logic turns out to be more main stream because of managing issues that have vulnerability, unclearness, boundary variety and particularly where framework model is mind boggling or not precisely characterized in numerical terms for the designed control activity. The origination of the fluffy rationale presented by Zadeh is a mix of fluffy set theory and fluffy derivation framework (FIS). Components of a fuzzy set have a place with it with a specific degree, called degree of membership. The level of enrollment is an outcome of mapping the contribution to specific standards utilizing a membership function (MF). The movement which maps the specified input information to the yield utilizing fluffy rationale is known as fuzzy inference.
A fluffy induction framework can be delegated:

a) Fuzzification

b) Inference motor

c) Knowledge base

d) Defuzzification

(a) Fuzzification:

Fuzzification is the way toward changing over any fresh worth toanalogous etymological variable dependent on certain MF.

(b) Inference motor:

Surmising motor recreates human choice.

(c) Knowledge base:

Information base consists MF definitions and important standards like IF-THEN or it is blend of condition partwith their related principles.

(d) Defuzzification:

Defuzzificationis the progression of changing the fluffy yield into a crisp numerical esteem. For instance, we take fundamental control input variable isthe DC-connect voltage mistake and yield of FLC is the peak value of the reference source current. The scope of operating current, standardization and de-standardization is one of the important configuration variables of fluffy regulator.

DESIGNING OF CONTROL RULES

Computational strategies decide the computational efficiency, processor memory necessity and preparing time. The fluffy control rules dependent on participation function defining or relate input factors to yield factors. The number and kind of MF decides the computational efficiency of fluffy control procedure. The assurance ofMFs relies upon the creator's insight and information. The shape choice of MFs influences how well a fuzzy system rules estimated a capacity.

Triangles or three-sided participation work (TMF) have been as often as possible utilized in a few uses of FLC. TMF are favored because of effortlessness, easy implementation, balanced along the pivot. Shows the MFs relating information and yield etymological factors. The number of phonetic factors is legitimately identified with the accuracy of approximating capacity and plays an important role for input-yield planning. In any case, a few limits need to consider while planning number of linguistic variables taking into account exactness and unpredictability of FLC.

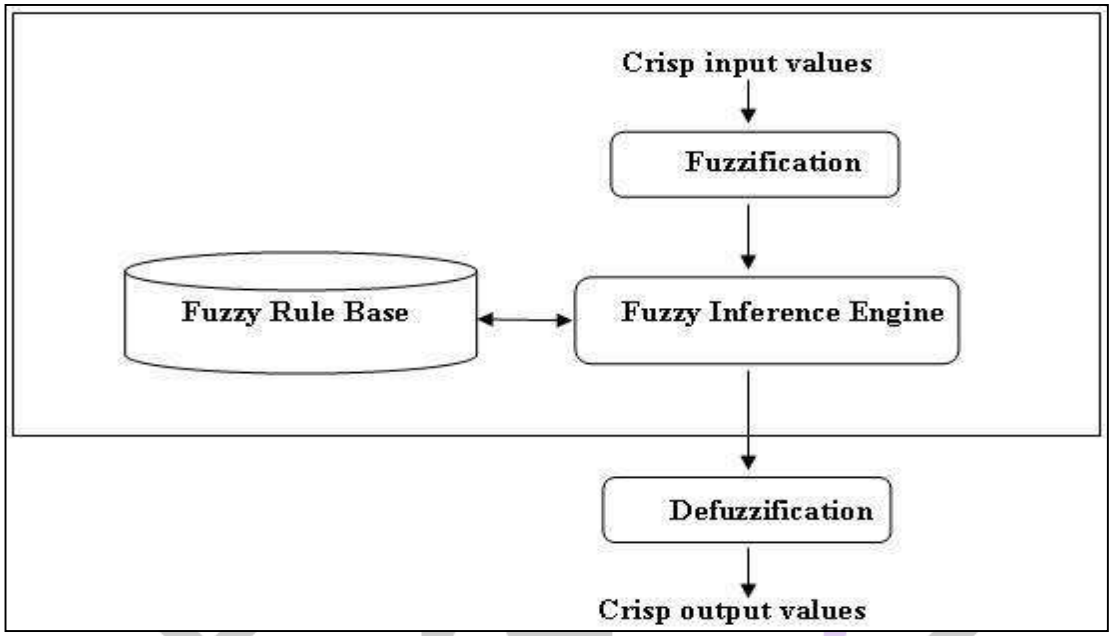

Fig.2. Detailed structure of fuzzy logic controller

A fuzzy regulator changes over a phonetic control procedure into a programmed control system, and fluffy standards are built by master insight or information data set. Initially, input voltage Vdcand the information reference voltage Vdc-refhave been set of the rakish speed to be the info factors of the fluffy rationale regulator. At that point the yield variable of the fluffy rationale regulator is introduced by the control Current Imax. To change over these mathematical factors into phonetic factors, the accompanying seven fuzzy levels are shown in table 1.

Table 1 Rule Table for Fuzzy Logic Controller

ΔE / E	NB	NM	NS	Z	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	Z
NM	NB	NB	NB	NM	NS	Z	PS
NS	NB	NB	NM	NS	Z	PS	PM
Z	NB	NM	NS	Z	PS	PM	PB
PS	NM	NS	Z	PS	PM	PB	PB
PM	NS	Z	PS	PM	PB	PB	PB
PB	Z	PS	PM	PB	PB	PB	PB

The control plot comprises of Fuzzy regulator, limiter, and three stage sine wave generator for reference current age and age of exchanging signals. The pinnacle estimation of reference flows is assessed by managing the DC interface voltage. The real capacitor voltage is contrasted and a set reference esteem. The mistake signal is then prepared through a Fuzzy regulator, which adds to zero

consistent blunder in following the reference current sign.

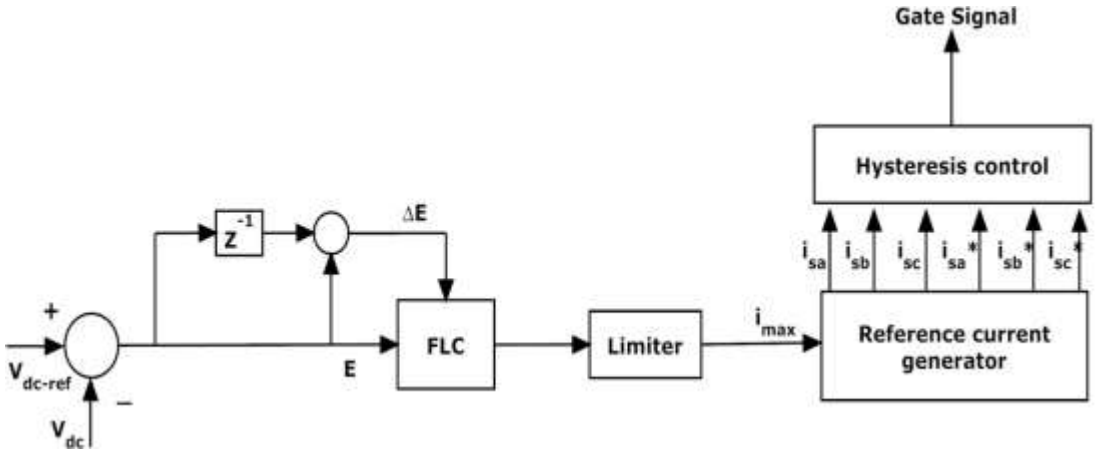

Fig.3.Fuzzy Controller

Results:

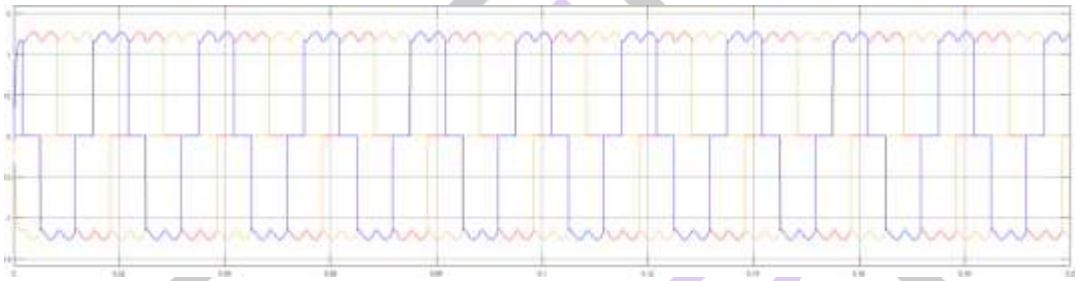

Fig.4.Normal grid system Load current without SHAPF

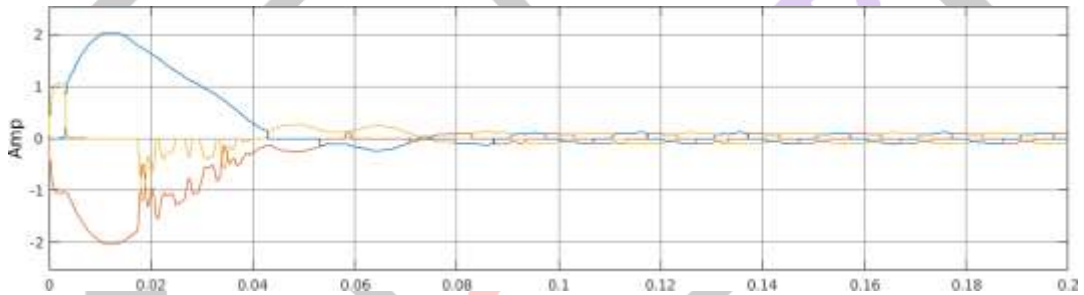

Fig.5.Indirect current control load current without SHAPF

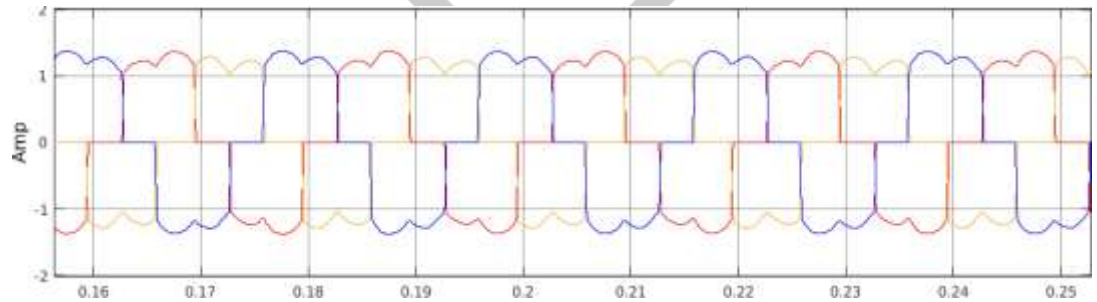

Fig.6.Instantaneous current control load current without SHAPF

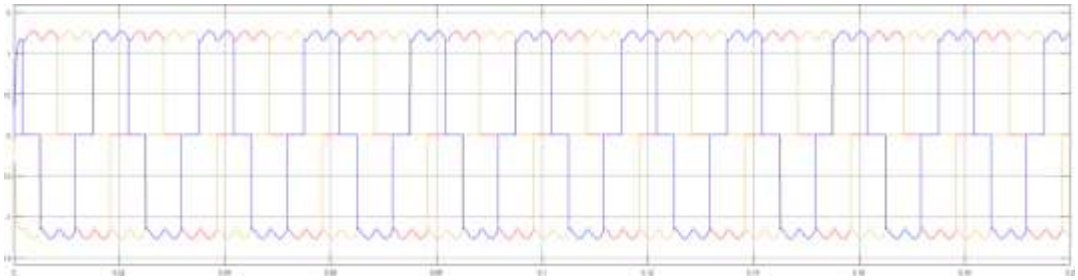

Fig.7.Normal grid system Source current without SHAPF

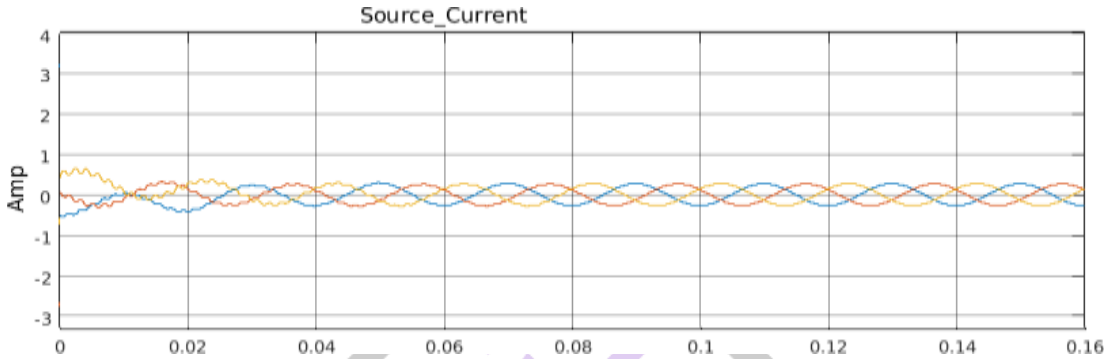

Fig.8.Indirect current control load current with SHAPF

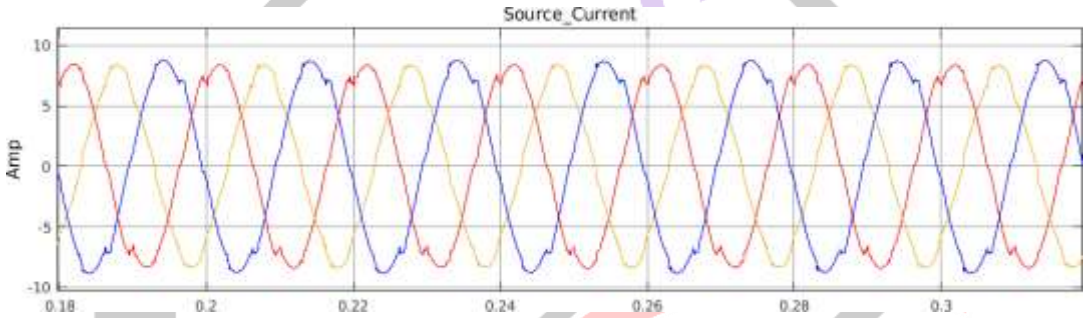

Fig.9.Instantaneous current control load current with SHAPF

CONCLUSION

In the area of active filters, SHAPF configuration is finding more applications because of the multiple functionalities it offers and reduced rating voltage source inverter requirements. In this paper a new control algorithm for SHAPF which simultaneously compensates source voltage unbalance and source current harmonics has been proposed, developed and tested. The control algorithm derives reference voltage for unbalance supply from the sequence components and reference voltage for harmonic compensation by decomposing voltage vector into quantities that represent different components of power. The generalized instantaneous power theory, where the instantaneous inactive power is defined as second-order tensor is used to define instantaneous power.

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