POWER QUALITY IMPROVEMENT IN 3-ϕ POWER SYSTEM USING SHUNT ACTIVE FILTER WITH SYNCHRONOUS DETECTION METHOD

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A Thesis that has been submitted in partial fulfillment of the necessities for the degree of

Bachelor of Technology in "Electrical Engineering"

By

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CERTIFICATE

This is to certify that the thesis entitled "**Power Quality Improvement In 3-Φ Power System Using Shunt Active Filter With Synchronous Detection Method**", submitted by Preetam Kumar Nanda (Roll-no-110EE0212) in partial fulfillment of the necessities for the award of Bachelor of Technology in Electrical Engineering during session 2013-2014 at National Institute of Technology, Rourkela is a bona fide record of research work carried out by him under my supervision and guidance.

The candidate has fulfilled all the prescribed requirements.

The Thesis which is based on his own work has not been submitted elsewhere for a degree/diploma.

In my opinion, the thesis is of standard required for the award of a bachelor of technology degree in Electrical Engineering.

Place: Rourkela

Dept. of Electrical Engineering   **Prof. A. K. Panda**

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ABSTRACT

Active filters with synchronous detection methodologies are vividly employed in distribution system to make sure that the harmonics generated by non-linear loads is reduced and results in less voltage distortion and leads to lesser power superiority problems. The three physical characteristics that mostly underline the power quality and a power quality issues are Voltage, Current and Frequency. Harmonics is defined as a disturbance demonstrated in current or voltage or frequency waveforms which result in devastation, or failure of final equipment. The greater switching frequency as well as the non-linearity in the characteristics of the power electronics equipments is mostly creditworthy for the power quality issue. So significance is being given to the procurement of Active Power Filters to equate these problems to improvise power quality and of all these, shunt active power filter is used to take care of harmonics of voltage and load currents and for reactive power compensating. The shunt active power filters have been built up on the basis of on control strategies like compensation scheme (p-q control) and instantaneous active and reactive current control scheme ($I_d - I_q$ control). Taking into consideration its superior quality, an analysis on the $I_d - I_q$ control scheme based shunt active filter presented in this project. The compensation is given by the usage of PI based controllers. A theory based study on both the compensation schemes is carried out in the project and then $I_d - I_q$ control scheme is implemented in simulation using MATLAB/SIMULINK® work and its harmonic compensation results are analyzed. Then synchronous detection scheme algorithms are worked out for unbalanced three phase systems and simulation is done.

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Chapter 1

INTRODUCTION

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1.1 INTRODUCTION

1.1.1 BACKGROUND AND REVIEW OF LITERATURE

WHAT ARE HARMONICS?

Harmonic is defined as "a sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency" [1]. Single-phase or three-phase rectifiers, thyristor converters and a huge number of low powered electronic-based equipments and gadgets, that provide static power are loads (non-linear) that give rise to huge disturbance in the mains(ac). Current disturbances, which might not be symmetric, effect voltage droppings across the given supply mesh/network impedance along with other unwanted phenomena (for instance, shunt and series resonance, or some kind of flickering) amounting to distorted supply line voltages, and as a result there is a decrease in the supply voltage quality [12].

DISADVANTAGES OF HARMONICS:

The existence of harmonics, when power lines are considered leads to even greater power losses in distributing, causing noise troubles in the communication systems and, every so often, causing breakdown of functioning of electronic apparatus, which have superior sensitivity for the reason that the addition of microelectronic control systems plus these systems lead to devices with low power and therefore a minute noise can be noteworthy. These become the reasons that put together the power quality issue as one of the most apprehensive issues as far as the final user is concerned [2].

Global standards regarding electrical energy intake oblige that electrical equipment ought not to production of harmonic components higher than particular specified values. In the meantime it is a necessity to get to the bottom of the harmonic tribulations caused by those equipments that have by now been installed. Utilization of the passive filters has been one of the typical solutions so as to resolve harmonic current related problems, however they give rise to numerous disadvantages, that is to say: they clean the bands they were formerly assigned; their functioning could not be restricted to a particular load; resonances can arise as the interaction among the passive filters and additional loads, with impulsive outcomes. Consequently, usual answers that depend on these filters in executing a harmonic decrease become useless. In these circumstances it was established that efficient results or

alternative are active filters that are capable in compensating distortions along with non-symmetric current due to non-linear and loads that are not balanced. As a result of the remarkable improvement in the past twenty years in the ground of power electronics equipments employing strained commutations, active filters found their way to be widely researched on and many a great number of papers have been published [1] –[12]. This paper accounts for one such type of extensively used filter i.e. the shunt type AF, and a synchronous detection scheme, in the latter stages.

1.2. TOTAL HARMONIC DISTORTION

1.2.1. TOTAL HARMONIC DISTORTION

The existence of harmonics results in greater losses in distribution of power, and is a source of problem by prying into communication systems and also sometime lead to operation failure of electronic apparatus, that are very critical since it contain microelectronic control systems, that work under absolute low levels of energy. Because of these troubles, the power quality issues provided to the final consumers are of prime concern [2].

IEEE Std. 519 was first formulated in the year 1981 to give indication about disturbances produced by static power converters and other non-linear power drawing equipments so that problems related to power superiority could be avoided. The IEEE Std. 519 limits specified for voltage harmonics and current harmonics are specified in Table 1. Reference-[12]

	Special System	General Application	Dedicated System
Notch Depth	10 percent	2 percent	50 percent
THD (Voltage)	3 percent	5 percent	10 percent
Notch Area*	16,400	22,800	36,500

Table 1: Distortion Limits according to IEEE 519 Standards

1.2.2 DEFINITIONS:

- **Distortion factor (harmonic factor).** The ratio between the RMS values of the distorted component to that of the fundamental, articulated as a percentage of the latter.

$$DF = \sqrt{\frac{\text{Addition of the squares of amplitudes of the harmonics}}{\text{Square of amplitude of the fundamental}}} \times 100\%$$

- **Voltage THD:** It stands for the Total Harmonic Distortion in the waveform of voltage. It is calculated as the ratio of the root of the sum of the second powers of the distortion in the voltage to the RMS value of the fundamental voltage [2] given by:

$$v_{THD} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + V_5^2 + \cdots}}{V_F} \times 100 \tag{1}$$

- **Current THD:** It stands for the Total Harmonic Distortion in the waveform of current. It is calculated as the ratio of the root of sum of the second powers of the distortion in the voltage to the RMS value of the fundamental current [2] given by:

$$I_{THD} = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + I_5^2} + \cdots}{I_F} \times 100 \tag{2}$$

The design is done keeping in mind the minimization of the Total Harmonic Distortion to keep it within limits specified in IEEE STD 519 [12].

1.2.3. ACTIVE POWER FILTERS

The application of passive filters as an explanation to resolve harmonic current tribulations has been tried, although passive filters have many disadvantages, specifically: they can clean only the frequencies they were in the past tuned for; their functioning cannot be restricted to a particular load; resonances might arise as a result of the interaction among the passive filters and other loads, with irregular results. To refrain from these disadvantages, latest efforts are focused in the advancement of active filters [5]. Various control strategies for implementation of active filters have been formulated over the years.

One of them is the instantaneous reactive power theory based (p-q scheme) control strategy [7]. There's an additional control method called instantaneous active and reactive current (I_d-I_q) method that operates on a rotating axis resulting due to voltages that don't use phase-locked loop [9].
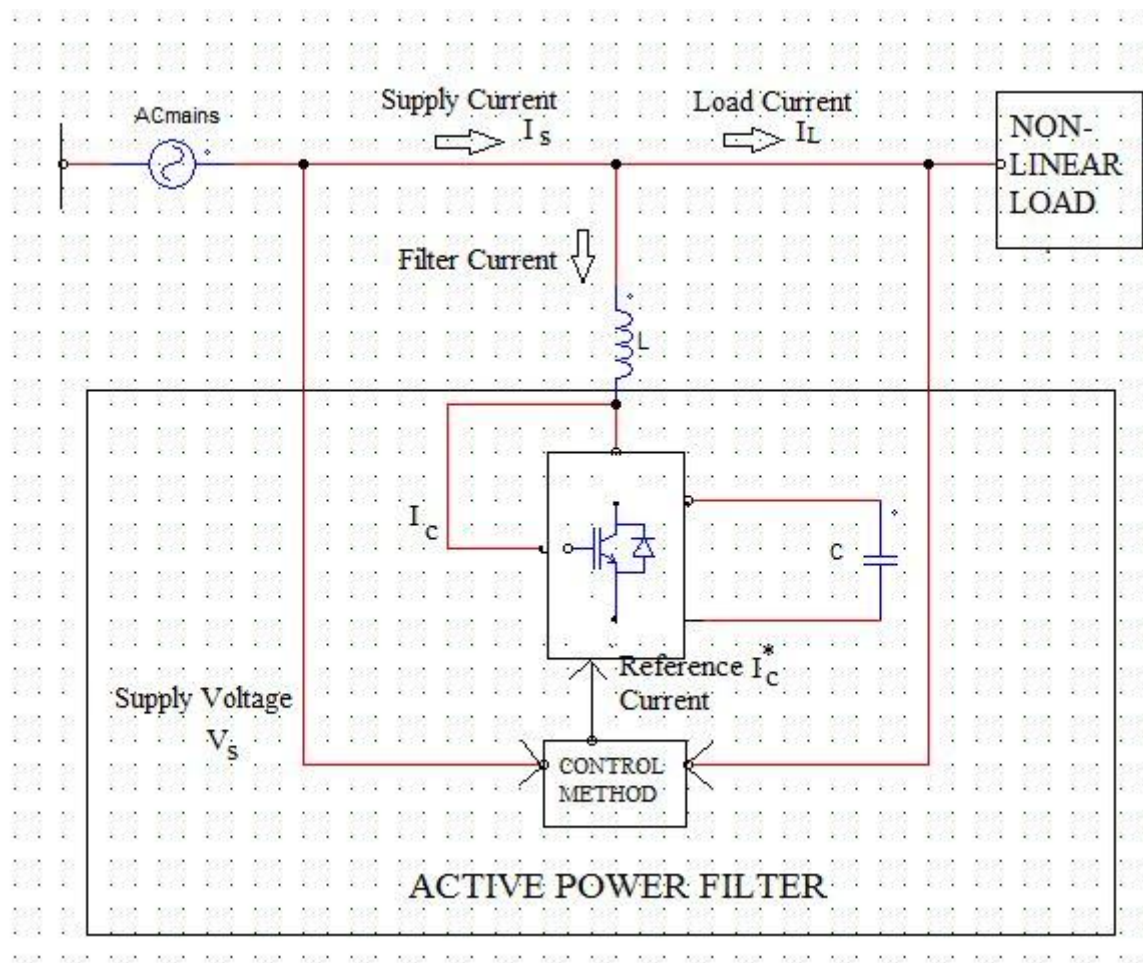

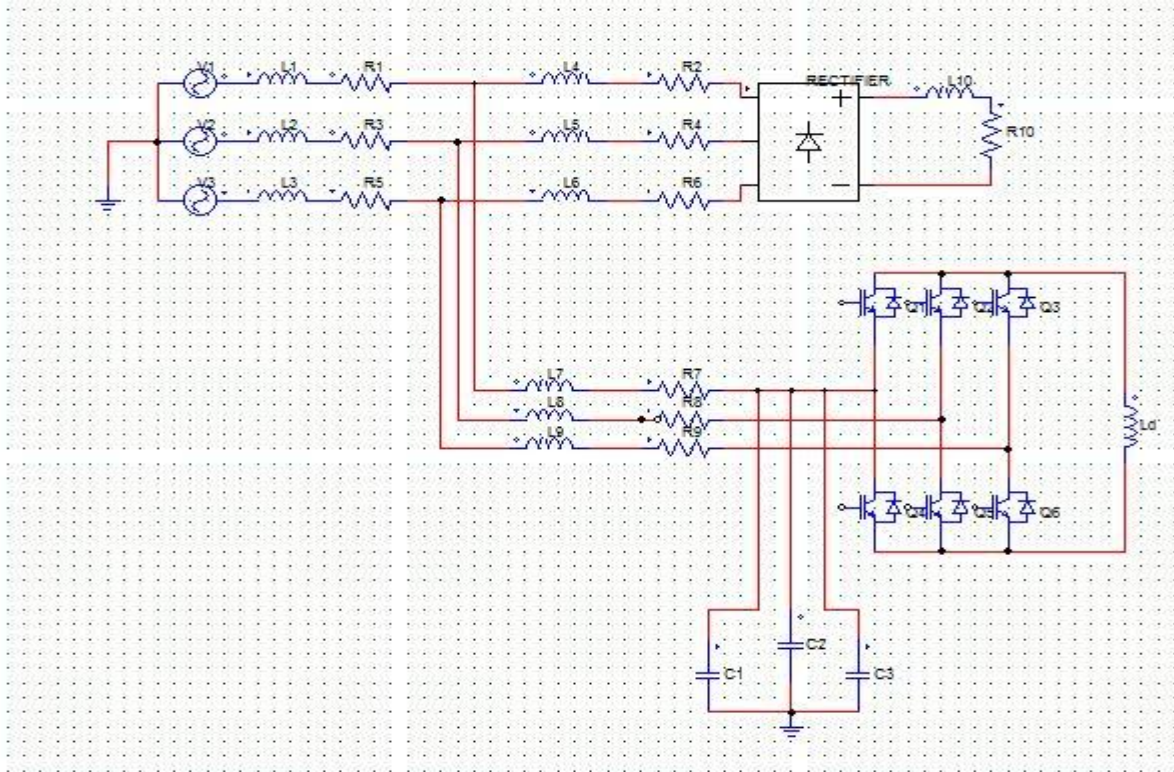Figure 1: Schematic Diagram- shunt active power filter

Fig 2: Typical 3 phase current source active filter.

Voltage source converters are generally given preference as compared to current source counterparts because:

1-It is more efficient

2-It has low initial cost.

They could be expanded in parallel connection to augment their accumulated rating and the rate of switching can be improved if carefully controlled so as to ensure their individual switching times don't overlap. That's why higher-order harmonics can be avoided by employing converters that don't sport increasing individual converter switching rates.
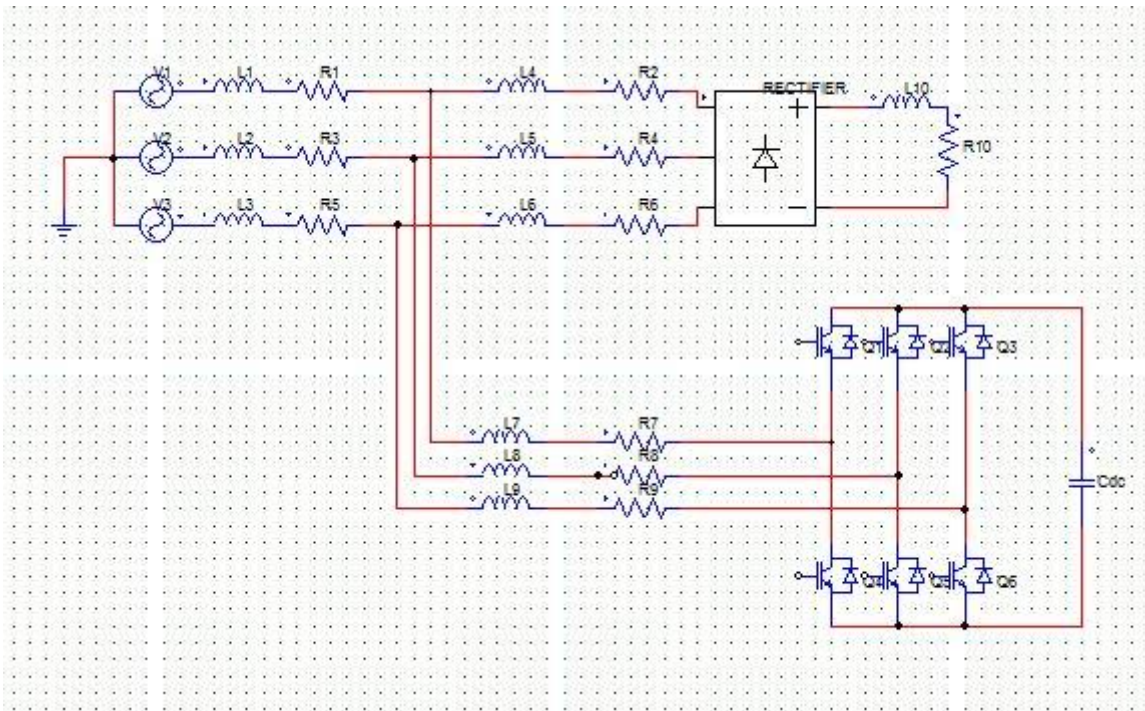
Reference has been taken from [8].

Fig. 3: 3-Ø voltage source active filter (VSAF)

1.3: OVERVIEW OF PROPOSED WORK DONE

Many Journals and papers were studied. The associated problems in quality of power were examined from Reference [1] and [2], also from where the IEEE regulations pertaining to power quality were deduced. Reference [4], [5] and [7] provide a picture of the active power filters while assisting in making understand the demerits of passive filters as compared to active filters. Post that the mathematical analysis of the control methods was done. Active and reactive power compensation method (p − q method) analysis was done with citation from reference [3], [6], [8], [7] and [10]. Then the mathematical study of more highly developed technique of active and reactive current compensation method (*id − iq* method) was performed and its advantages over p − q method were analyzed with aid from reference [9], [11] and [12]. These references helped in designing the circuit parameters for each block of the shunt active filter based on $I_d − I_q$ method for a given balanced 3 − phase supply system. Reference [13] was helpful for studying synchronous detection technique and its advantages as far as unbalanced three phase power systems are concerned, are studied.

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CHAPTER 2

Mathematical Analysis

2.1 MATHEMATICAL ANALYSIS OF P – Q METHOD

2.1.1 Clarke's Transformation

The expression instantaneous reactive power is a distinctive value for random three phase current waveforms and voltage waveforms along with all vague waveforms, from Reference [1]. By means of instantaneous imaginary power, a compensator eliminates the harmonics having the frequencies $(f + 6f_0)$
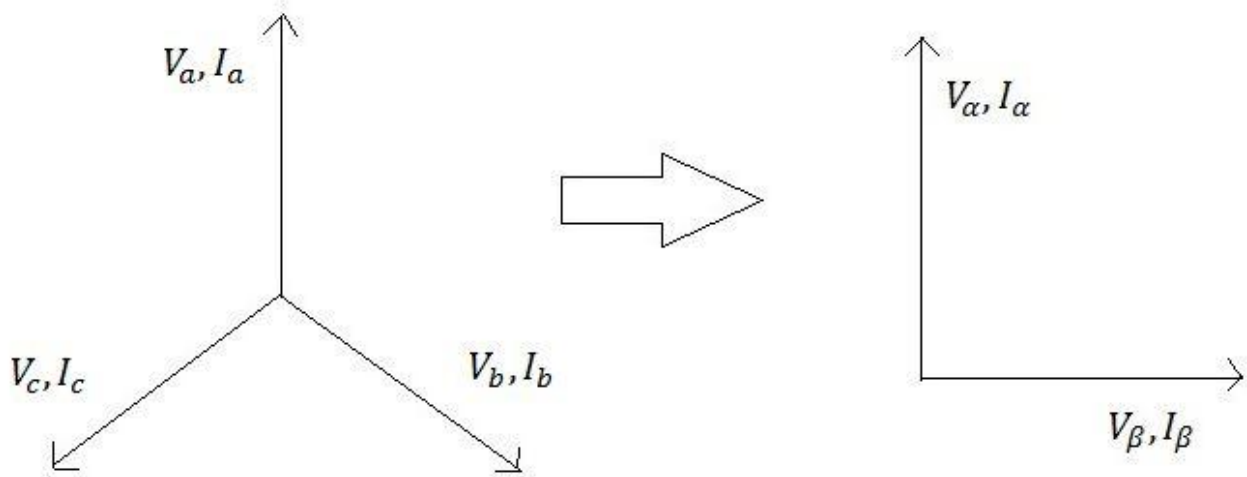

Figure 4: a-b-c to α-β coordinates transform

For taking care of the instant values of the current waves and voltage ones in 3-Ø circuits, provision of the quantities in the form of instant space vectors will suffice. In a-b-c axis system, the three axes are set on a particular plane, with a phase difference of $2\pi/3$.

The instant space vectors, I_a and V_a are fixed on the a-axis, and the direction and amplitude differ with the course of moment. Similarly, b axis and c axis can be observed [1]. The transformation into α – β coordinate system is given [3] as:

$$\begin{bmatrix} U_\alpha \\ U_\beta \\ U_0 \end{bmatrix} = \frac{\sqrt{2}}{\sqrt{3}} \begin{bmatrix} 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \\ 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \end{bmatrix} \begin{bmatrix} U_a \\ U_b \\ U_c \end{bmatrix} \tag{3}$$

$$\begin{bmatrix} I_\propto \\ I_\beta \\ I_0 \end{bmatrix} = \frac{\sqrt{2}}{\sqrt{3}} \begin{bmatrix} 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \\ 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \end{bmatrix} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} \quad\quad (4)$$

If we presume a balanced three phase system with $I_0 = 0$ then (3) and (4) reduce to:

$$\begin{bmatrix} U_\propto \\ U_\beta \end{bmatrix} = \frac{\sqrt{2}}{\sqrt{3}} \begin{bmatrix} 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} U_a \\ U_b \\ U_c \end{bmatrix} \quad\quad (5)$$

$$\begin{bmatrix} I_\propto \\ I_\beta \end{bmatrix} = \frac{\sqrt{2}}{\sqrt{3}} \begin{bmatrix} 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} \quad\quad (6)$$
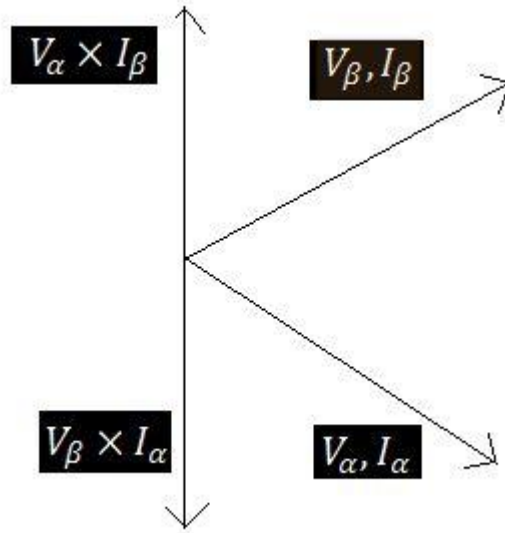

Figure 5: Instantaneous space vectors

2.1.2 Compensation Current Calculation

The multiplication of instantaneous voltage on a single axis with the instant current in that particular one provides us with the real power (P) of that instant **[7].** Similarly the multiplication of instantaneous voltage on a particular axis and the instant current at right angles generates imaginary power (Q) of that instant as given by (7) and (8) .

In α-β coordinates, $P = U_\alpha \times I_\alpha + U_\beta \times I_\beta$ (7)

In α-β coordinates, $Q = U_\alpha \times I_\beta + U_\beta \times I_\alpha$ (8)

From (7) and (8) we get the following matrix equation:

$$\begin{bmatrix} P \\ Q \end{bmatrix} = \begin{bmatrix} U_\alpha & U_\beta \\ -U_\beta & U_\alpha \end{bmatrix} \begin{bmatrix} I_\alpha \\ I_\beta \end{bmatrix}$$ (9)

Now I_α and I_β can be determined from (7) and divided into components as shown in (10)

$$\begin{bmatrix} I_\alpha \\ I_\beta \end{bmatrix} = \begin{bmatrix} I_{\alpha p} \\ I_{\beta p} \end{bmatrix} + \begin{bmatrix} I_{\alpha q} \\ I_{\beta q} \end{bmatrix}$$ (10)

P and Q from (8) can be divided into real and alternating parts:

$P = P_{avg} + P_{osc}$ (11)

$Q = Q_{avg} + Q_{osc}$ (12)

Where, P_{avg} and Q_{avg} are average terms and P_{osc} and Q_{osc} are the oscillatory terms.

The oscillatory parts stand for the higher order harmonics or disturbances. Therefore, the oscillation power ought to be remunerated by active power filter consequently such that real power parts stay in the circuit and thus rating is minimized.

The average power component is truncated by means of High Pass Filter. The power to be compensated is given as follows:

$P_c = -P_{osc} \ and \ Q_c = Q_{osc}$ (13)

This leads us to parameters in α- β coordinate system that can be got by eq. (14)

$$\begin{bmatrix} I_{c\alpha} \\ I_{c\beta} \end{bmatrix} = \frac{1}{V_\alpha^2 + V_\beta^2} \begin{bmatrix} V_\alpha & -V_\beta \\ V_\beta & V_\alpha \end{bmatrix} \begin{bmatrix} P_c \\ P_c \end{bmatrix}$$ (14)

Now we apply Clarke's Transformation and determine the compensation currents, I_{ca}, I_{cb} and I_{cc} :

$$\begin{bmatrix} I_{ca} \\ I_{cb} \\ I_{cc} \end{bmatrix} = \frac{\sqrt{2}}{\sqrt{3}} \begin{bmatrix} 1 & 0 \\ -1/2 & \sqrt{3}/2 \\ -1/2 & -\sqrt{3}/\sqrt{2} \end{bmatrix} \begin{bmatrix} I_\alpha \\ I_\beta \end{bmatrix} \tag{15}$$

Ergo, Eq. (15) shows the reference current of the converter that should be given back to the line through an apt controller on the basis of PI control.

2.2 MATHEMATICAL ANALYSIS OF $I_D - I_Q$ METHOD

Here the currents I_{ci} are got the components I_α and I_β of the non-linear load. Similarly, α-β components are to be deliberated as done previously in (5) and (6). Though, the *d-q* load current parts are derivatives of a synchronously referenced frame on the basis of **Parks Transformation** (Reference has been taken from [9]), where θ denotes the instantaneous angle of space vectors.

$$\begin{bmatrix} I_{ld} \\ I_{lq} \end{bmatrix} = \begin{bmatrix} cos\theta & sin\theta \\ -sin\theta & cos\theta \end{bmatrix} \begin{bmatrix} I_{l\alpha} \\ I_{l\beta} \end{bmatrix} \tag{16}$$
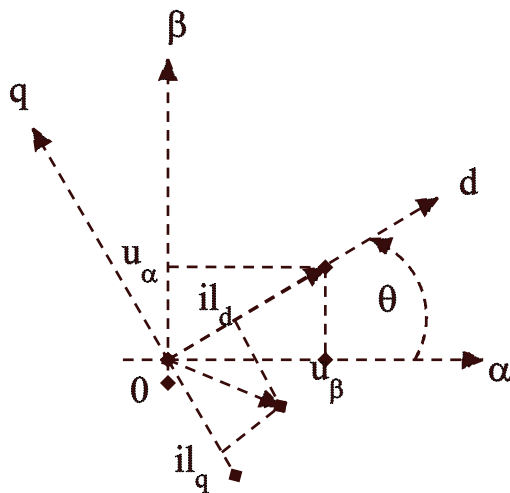

Figure-6: Rotating frame and Stationary Frame Depiction of Vectors

2.2.2 Compensation Current Formulation

D-Q components i.e. I_d and I_q have an standard value (dc quantity) and another vacillating quantity or alternating part [6]:

$$I_{ld} = I_{ldavg} + I_{ldosc} \tag{17}$$

$$I_{lq} = I_{lqavg} + I_{lqosc} \tag{18}$$

The $I_d - I_q$ theory says that first harmonic of the positive sequence current provides the component, I_{ldq1h}^+. This component which is the dc part does not undergo shift in frequency owing to the harmonics. The non-dc parts give the left-over higher order harmonics along with the first harmonic pertaining to the negative sequence, $I_{ldq1h}^+ + I_{ldq1h}^-$ .All these are made under the presupposition of load conditions that are balanced. The dc components and the oscillating parts could be moved out by passing it across a Butterworth Low Pass Filter that provides the dc component and therefore subtracting it from the real signal we find the oscillating component with high frequency. Ergo, in this scheme we get the compensating currents [6]:

$$\begin{bmatrix} I_{c\alpha} \\ I_{c\beta} \end{bmatrix} = \frac{1}{V_\alpha^2 + V_\beta^2} \begin{bmatrix} V_\alpha & -V_\beta \\ V_\beta & V_\alpha \end{bmatrix} \begin{bmatrix} I_{cd} \\ I_{cq} \end{bmatrix} \tag{19}$$

From the α-β coordinates of the compensated current the a-b-c axis components can be found out by Clarke's transformation's inverse as stated above.

CHAPTER 3

Design of Control Circuit based on $I_d - I_q$ method

3.1 INTRODUCTION

Providing for the compensation to the lines, a 3 phase IGBT based on VSI is utilized. This makes a simple as well as robust design mechanism and proving for good dynamics even when well-known faults are present. The current controller is put to use that is composed of three self-regulating two -leveled comparators for hysteresis functioning on a three leg Inverter (VSI). This gives the compensated harmonic to be provided that consists of two parts namely – 1-Harmonic Current Generator and 2-DC Voltage Regulator [9].
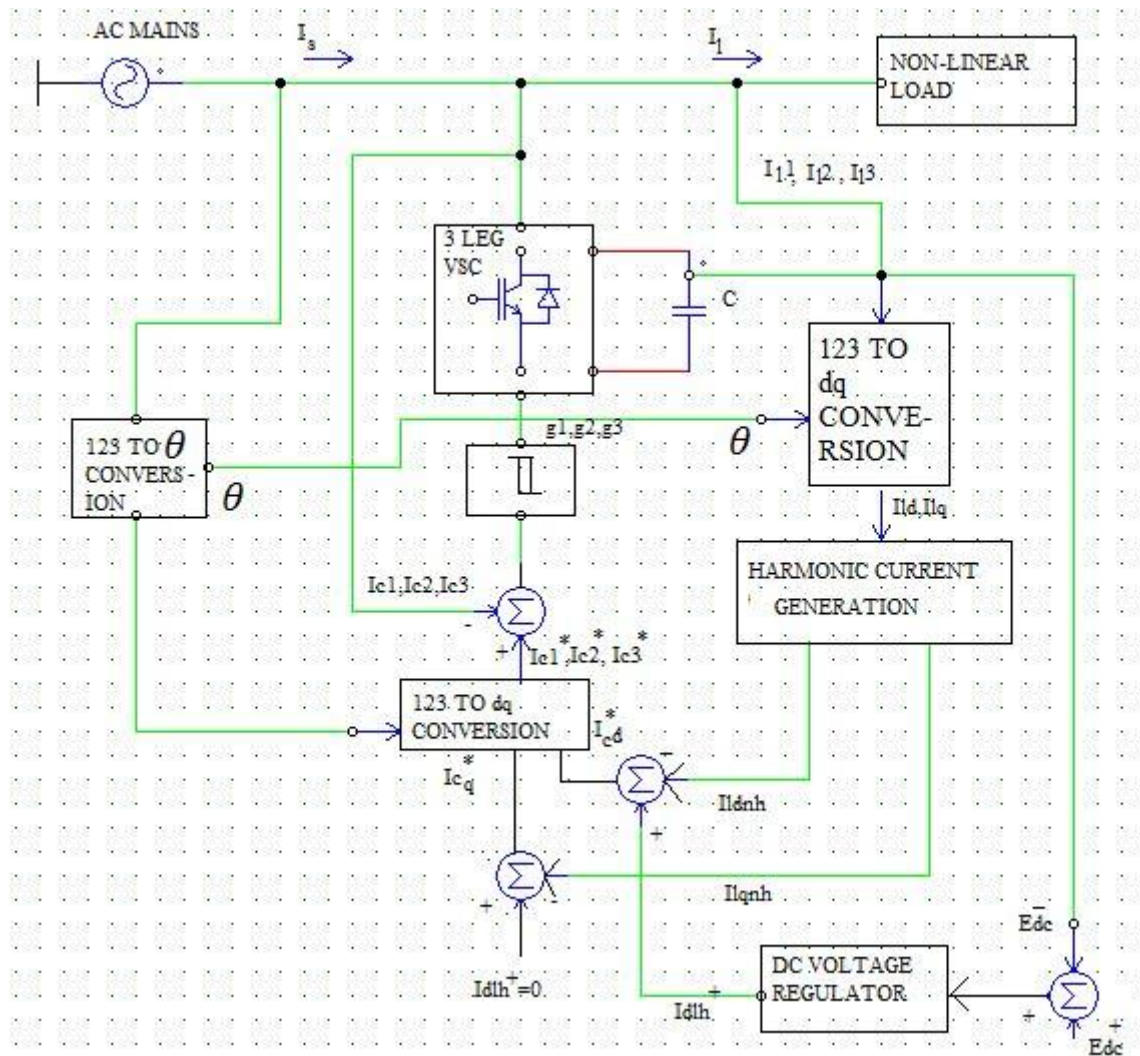
Figure 7: AF Control system based on d-q method

3.2 HARMONIC CURRENT GENERATOR

The currents are calculated with the algorithms of Park Transformation and injection circuit of disturbance current and using the dc voltage regulator. At first a-b-c to d-q axis conversion takes place by the Park Transformation model that is according to equation 16. From there the load currents are calculated. The foremost harmonic current (carrying +ve sequence load) is converted into dc parts. Then the first harmonics of -ve sequence and remaining distortions are converted into alternating parts that undergo a swing in frequency within the band. As a result, dc parts that should be preserved in the mains relate to the positive sequence of the first harmonic currents **[9].**

Then obtained signal is passed through a Butterworth LPF of order four. After subtracting this obtained signal from the input, we obtain the higher order d-q harmonic parts as shown in the figure.
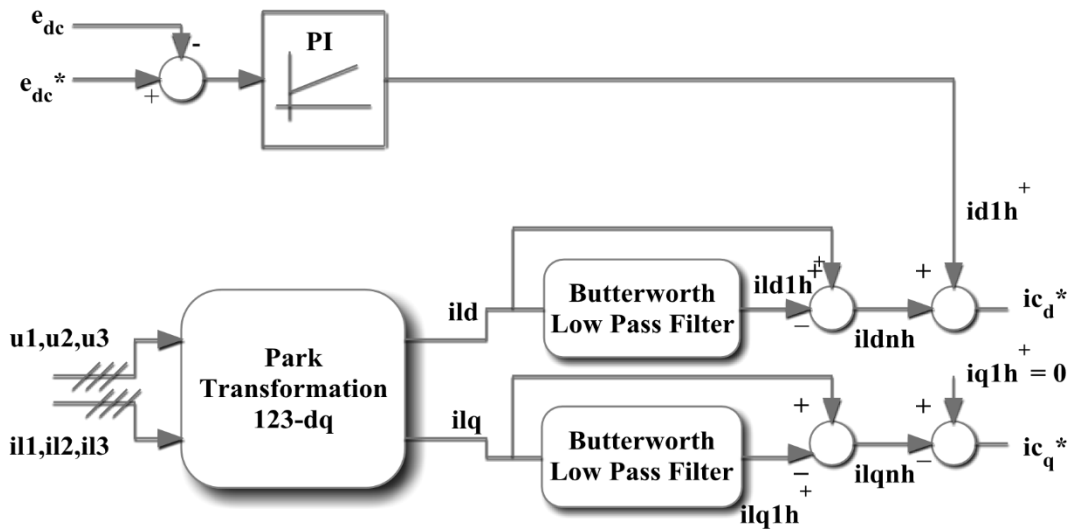

Figure 8: Park Transformation and Harmonic Current Generator circuit.

3.3   DC VOLTAGE REGULATOR

The regulation of voltage on dc side in VSI is carried out by the DC Voltage regulator component. It consists of a PI controller to carry out the operation. The input perceived by it is voltage error in the capacitor. By regulating the +ve sequence of first harmonic d-axis part, active power inflow to the inverter is controlled. Hence the capacitor voltage is also taken care of. This control is done with the help of a PI controller. Expected d–axis

reference is formulated by subtracting the d-axis components of higher order from the DC voltage regulator output. Similarly the q-axis reference current is calculated [10] and [12].

3.4   SYSTEM PARAMETERS

AC Supply Voltage	220 V RMS
Fundamental frequency	f =50 Hz
Source Inductance	0.1 milli Henry
Load	R/L=8 Ω / 100 mH
DC bus capacitor	C=4 mF
Filter Inductor	L=1 mH

Table 2: System Parameter Values taken for simulation purpose.

CHAPTER 4

Simulation Results and Discussion

4.1 3-φ 3 WINDING BALANCED MAIN VOLTAGE CURRENT HARMONIC COMPENSATION WITH PI CONTROLLER
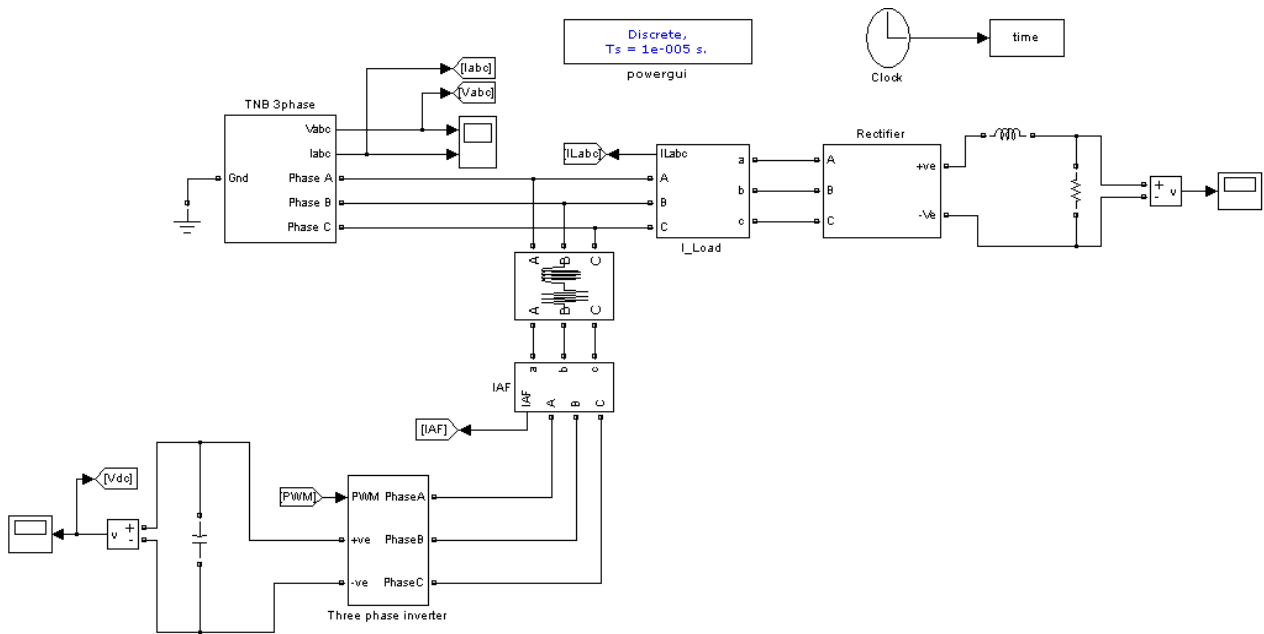
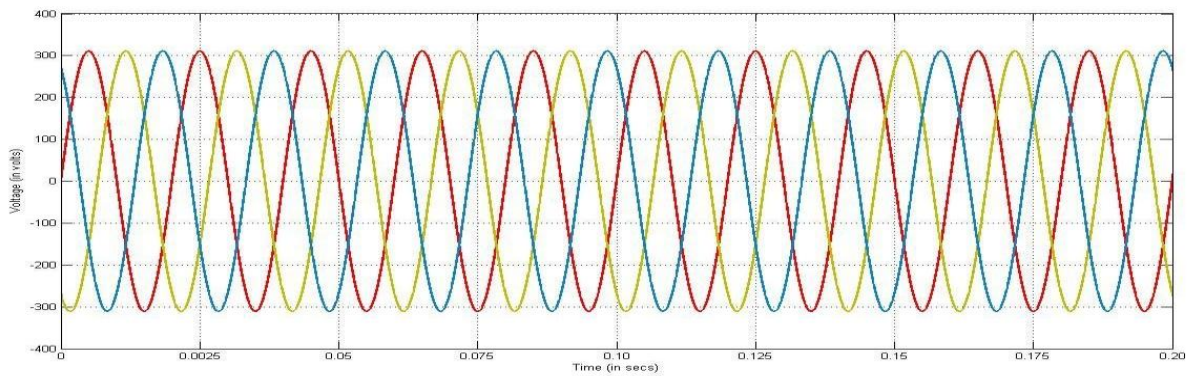Fig.9: SIMULINK Model of an Active Filter

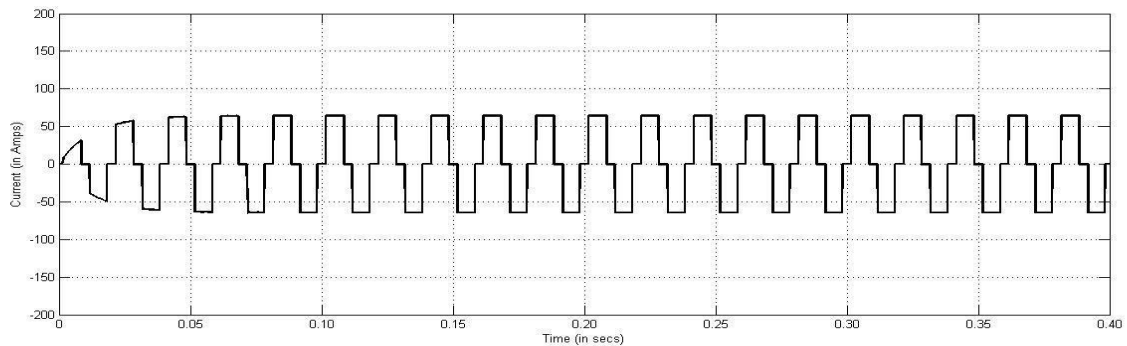
Figure 10: 3-phase Source waveform of voltage

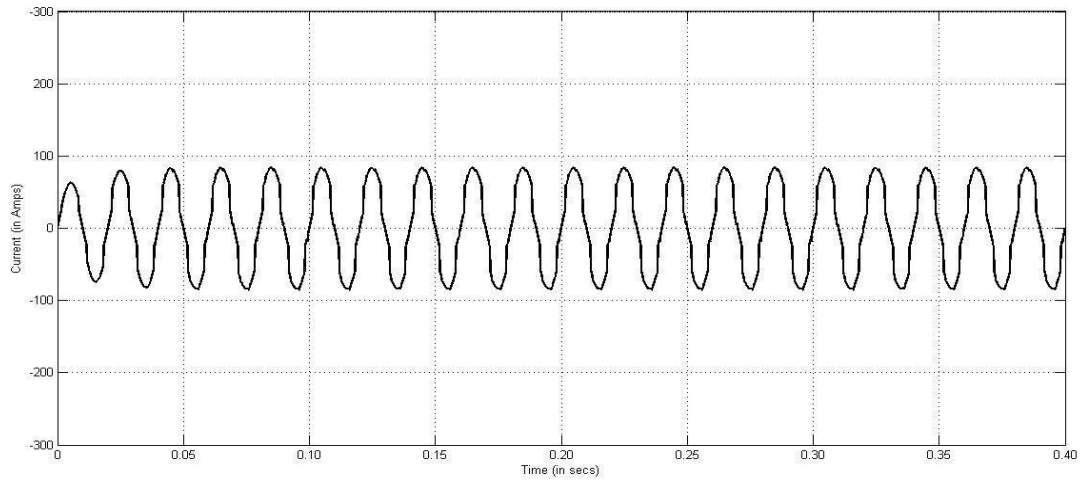Figure 11: Load Current Waveform with harmonics.
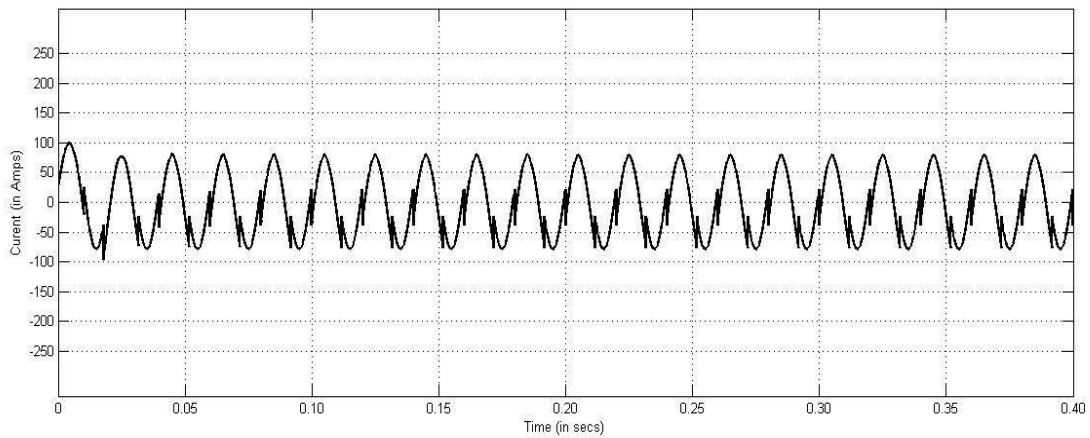
Figure-12: Compensated Load Current

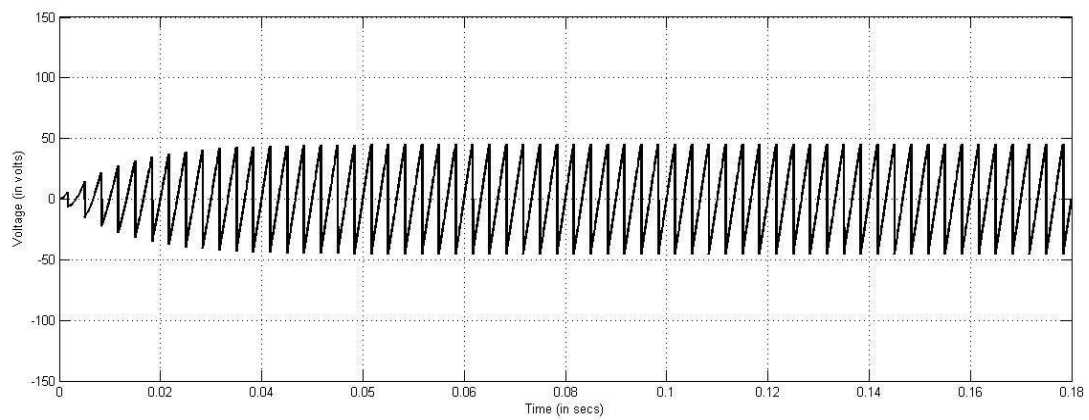Figure 13: Filter Current or Compensation Current

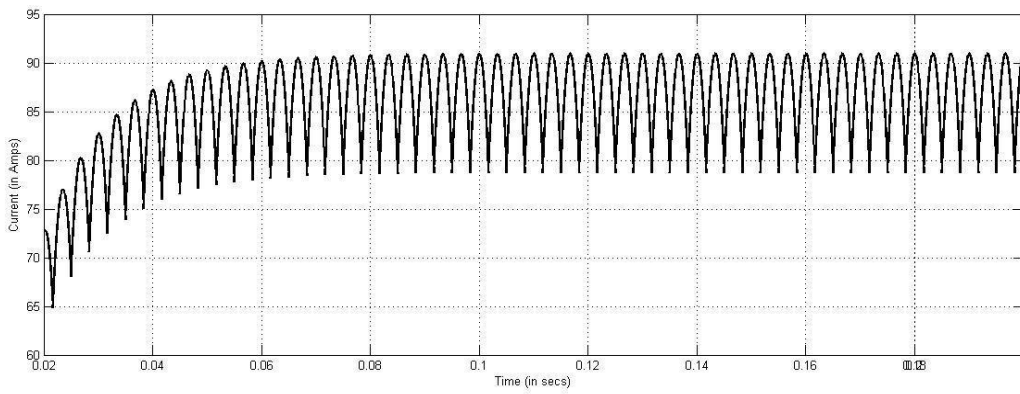Figure 14: Load current waveform after Park's Transformation

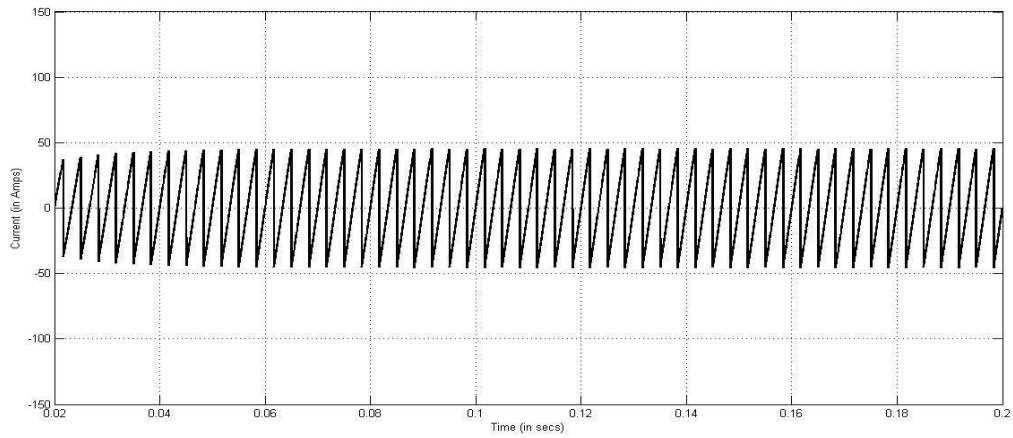Figure 15: Filtered Load current after Park's Transformation.

Figure 16: Filtered Load current waveform
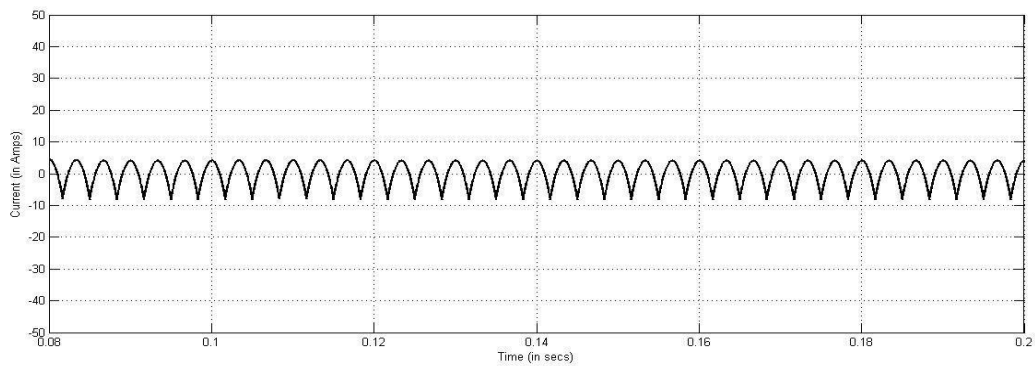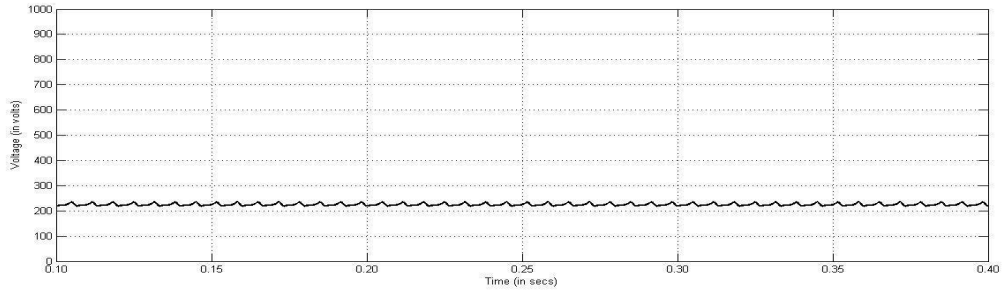

Figure 17: Filtered load current waveform
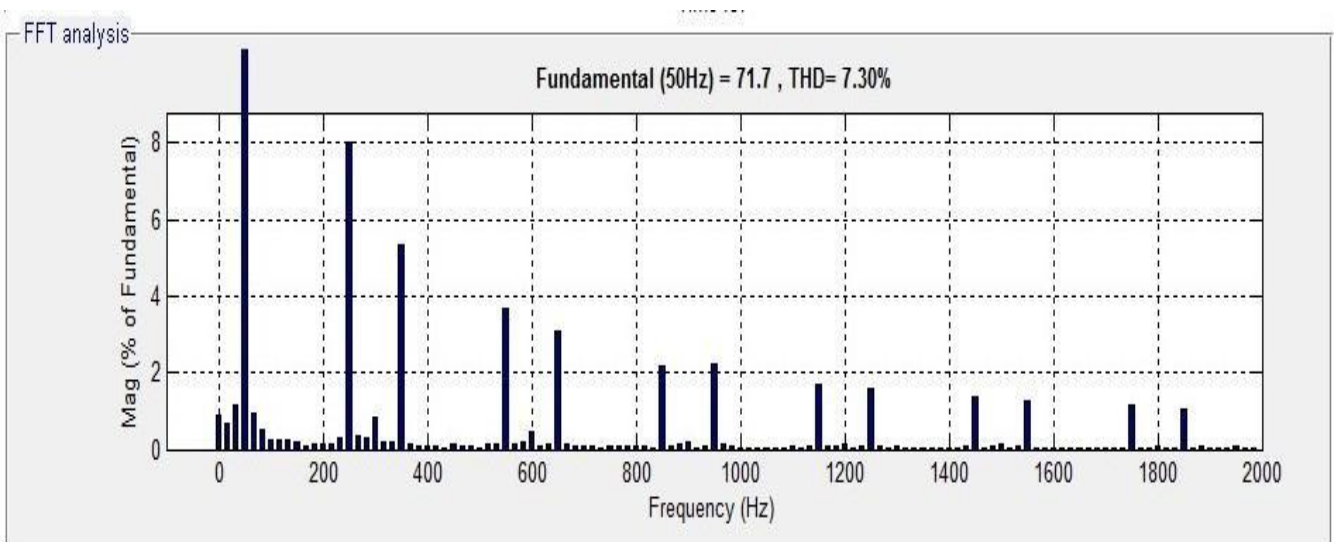
30

Figure 18: DC Link Voltage waveform

Figure 19: Plot of Magnitude vs. Frequency

CHAPTER-5

HARMONIC CURRENT COMPENSATION FOR UNBALANCED SYSTEMS
WITH SYNCHRONOUS DETECTION SCHEME

5.1- INTRODUCTION

In instantaneous power theory, there is a requirement of a source that is balanced . But, in pragmatic distributions, it becomes hard to provide balanced voltages across the circuit. Hence, taking care of unbalanced sources with respect to harmonics becomes a challenge., The synchronous detection method [13] is a scheme that works on phase by phase basis i.e. on every phase and calculations are done to obtain required compensating parts. Three different kind of approaches that use same power, similar current, and using equal resistance conceptions in the synchronous detection scheme are discoursed.

The gains of this very scheme when compared to other methods are low alteration when signal is detected, fast waveform tracking capability in the midst of changes and differences, leading to better gains. This scheme has been vividly implemented in communication field. Generally, it was implicated for detection of single-phase signal. Lately, the synchronous scheme has hold its grip on an application in arc furnace. When we consider the circuit dynamics of single phase, an average power consumption of P_{dc} gives the active component of the line current as articulated by i(t)=$2\left(\frac{P_{dc}}{V_m^2}\right)v(t)$ [13]. This anticipated method tailored itself to be fit for application in three phase circuits. The pith in expanding this scheme from single phase to three phase was to take care of each phase singularly, and share out the feedback parts(compensation) equally into each phase. Ergo, there is no necessity for a balanced three-phase sysetm. The advantage is that it blends in when varied functioning are considered, related to reactive compensation harmonic distortion compensation in whatever functional distribution system prone to losing voltage balance or phase faults. This method has various advantages like balancing unbalanced line parts, attaining near unity power factor, and getting rid of unwanted harmonics on the user end [13].

Following three planned approaches form the basis of synchronous detection scheme:

After Compensation,

(a) Each phase takes in same real power from the total available.

(b) Each line has same line current.

(c) Each phase caries similar resistances.

5.2-SAME POWER SYNCHRONOUS DETECTIONSCHEME

Here,it is presumed that the consumption of real part power to every phase post compensation is divided equally [13].

$$P_a = P_b = P_c = \frac{P_{dc3}}{3} = P \tag{20}$$

where P_a, P_b and P_c denote real power burden for phases apiece, along a, b and c axes, respectively and P_{dc3} is the gross real power consumed by the load. Applying instantaneous power algorithms, P_{dc3} is calculated from an addition of the instant powers of all the phases.

By equal division, we get the compensated currents $I_{acp}(t), I_{bcp}(t)$ and $I_{ccp}(t)$, by the following equations [13]:

$$I_{acp}(t) = (2P / V_{am}^2) V_{an}(t) \tag{21}$$

$$I_{bcp}(t) = (2P / V_{bm}^2) V_{bn}(t) \tag{22}$$

$$I_{ccp}(t) = (2P / V_{cm}^2) V_{cn}(t) \tag{23}$$

where P denotes the compensation power given out to every phase , V_{am} denotes the highest voltage magnitude of phase A referred to load side, and accordingly the compensating current is obtained along each axis:

$$I_{can}(t) = -I_{acp}(t) + I_{an}(t) \tag{24}$$

$$I_{cbn}(t) = -I_{bcp}(t) + I_{bn}(t) \tag{25}$$

$$I_{ccn}(t) = -I_{ccp}(t) + I_{cn}(t) \tag{26}$$

The block representation for the same power synchronous detection (PSD) scheme is depicted in given figure [13].
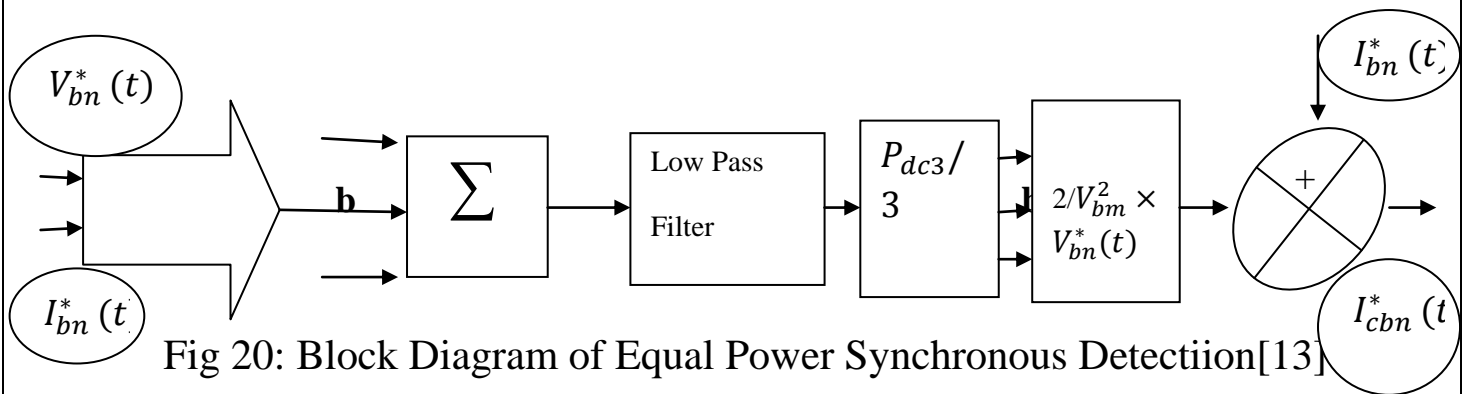

Fig 20: Block Diagram of Equal Power Synchronous Detectiion[13]
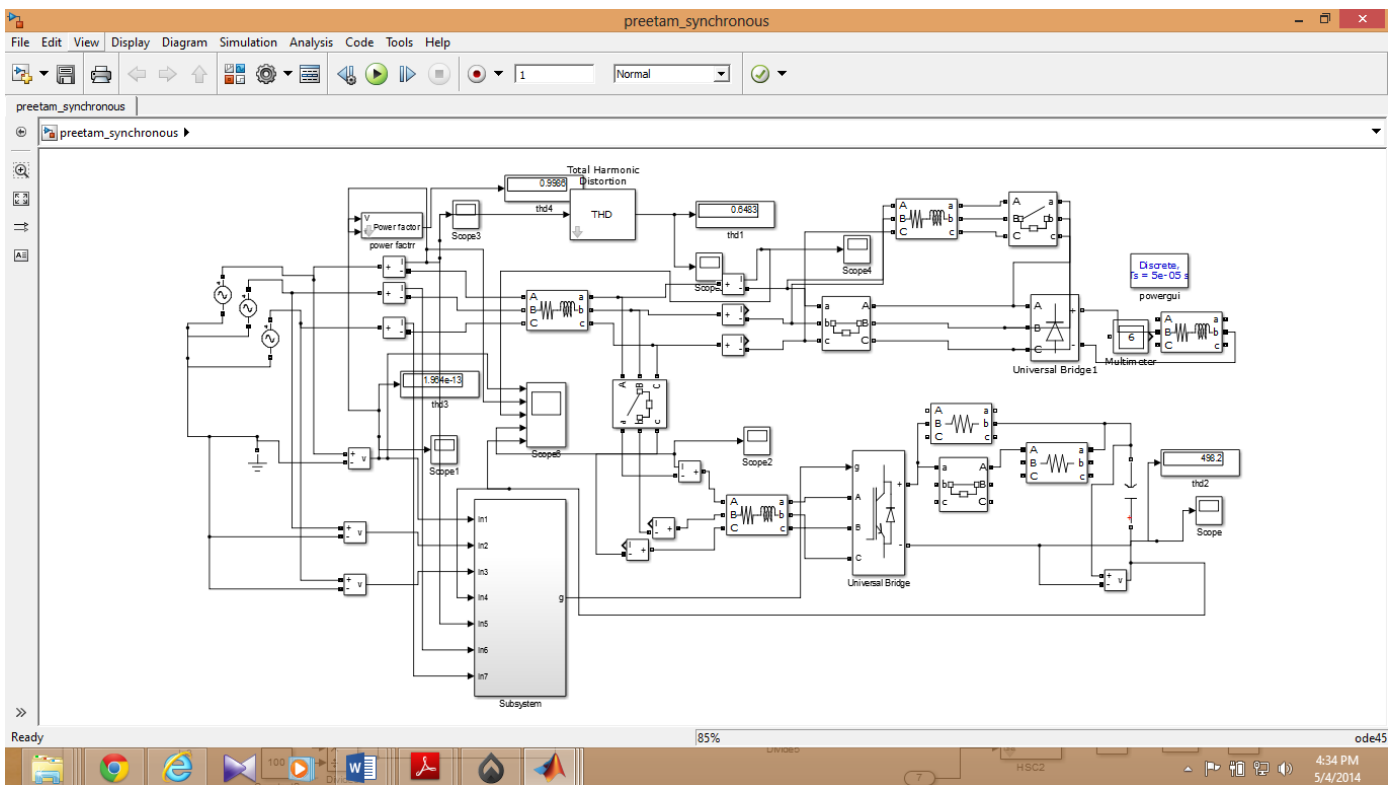
5.3- SIMULATION RESULTS

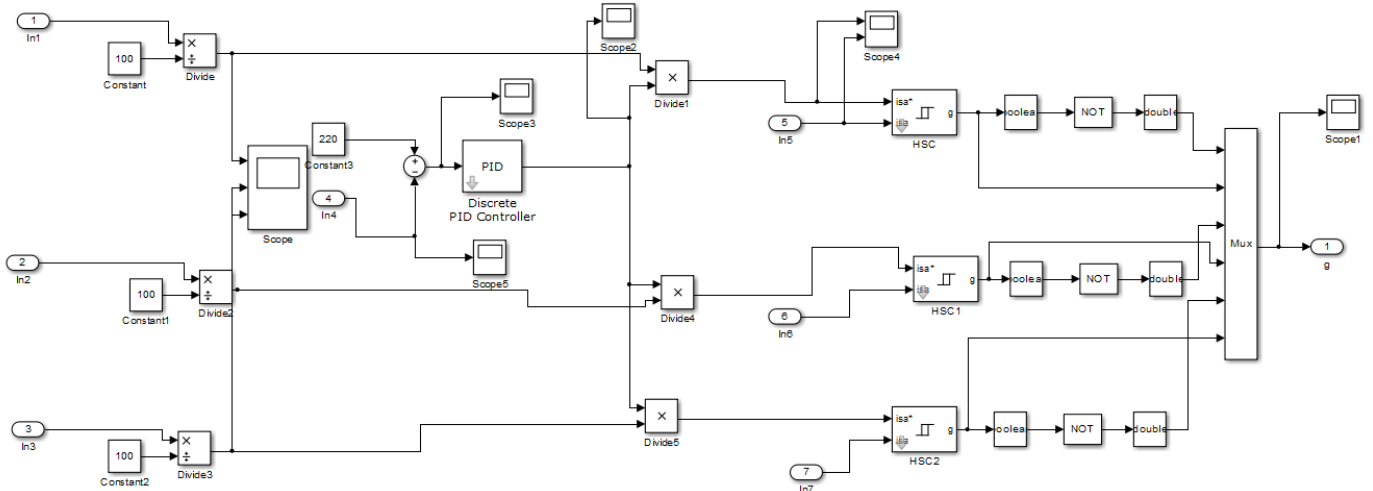Figure 21: SIMULINK diagram of synchronous method active filter

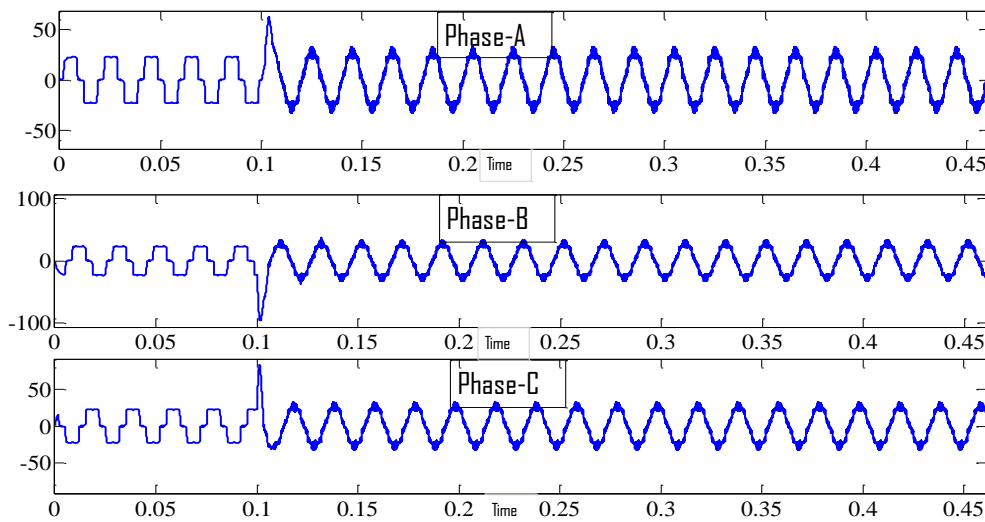Figure 22: Synchronous method harmonics detection subsystem

Figure 23: Output phase currents
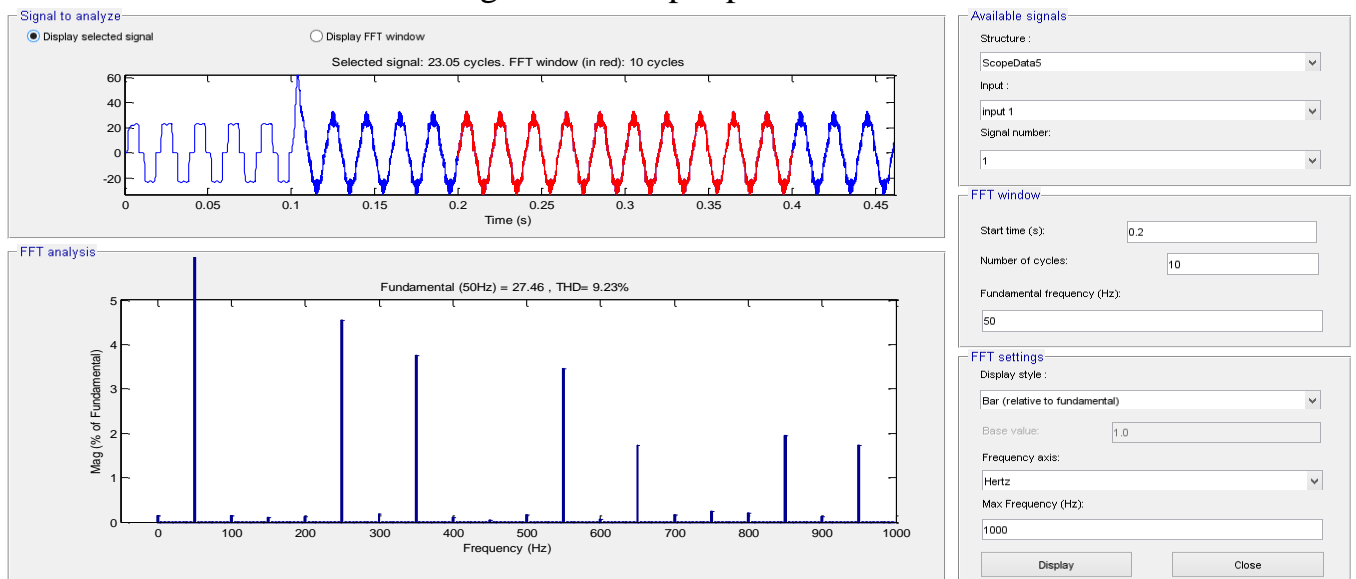
Figure 24: Fourier analysis of output phase current

CHAPTER-6

DISCUSSIONS

6.1-DISCUSSIONS

We carry out simulations on the active and reactive component methodologies. The application is developed and run in a **MATLAB/SIMULINK** tool to verify the results. The parameters are provided in Table 2. Simulation uses Butterworth Low Pass Filter of order four having a cut off frequency of 25 Hz. The gross THD is found using d-q method using PI controller is 7.35%. Then simulation is done for synchronous detection method.THD comes out be 9.3%. The application is also developed in a **MATLAB/SIMULINK** tool to prove the result.

CHAPTER 7

Conclusion

7.1 CONCLUSIONS

A synchronous detection scheme and a filter based on the principle of $i_d - i_q$ compensation scheme has been projected in this work. Also synchronous detection scheme is put to application in SIMULINK. A mathematical study of p-q method as well as $i_d - i_q$ compensation method has been done to assimilate the control schemes. As the $i_d - i_q$ compensation mechanism is dependent on a rotating frame resulting from mains voltages that does not incorporate phase locked loop and carries better-quality compensation results, simulation was done based on this control method. When we consider balanced conditions the $i_d - i_q$ control scheme is found to have satisfactory harmonic compensation performance. Here the harmonics were produced by three – leg VSC and by the application of the Hysteresis controller. The control scheme depicted vows for the operation of the Active Filter in changing frequency circumstances sans any adaptation. But the above method deals with only a balanced system, therefore synchronous detection method is used to take care of unbalanced three phase systems. With regard to synchronous detection method, from the results and simulation findings, the projected synchronous detection scheme is aptly fit for harmonic compensation in a system that is unbalanced.

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