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AAN Based Hybrid Active Power Filter for Power Quality Improvement

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Abstract*: The Active filtering of electric power has now turned into a develop innovation for consonant and receptive power pay in two-wire (single stage), three-wire (three stage without nonpartisan), and four-wire (three stage with impartial) AC power systems with nonlinear burdens. This paper presents outline, reproduction and advancement of hybrid active power filter (HAPF) with artificial neural network controller (ANN). The proposed model tested with the three phase power supply and the three phase distorted power supply. The proposed model is tested for the two cases first one for the ideal power supply and second one for the distorted power supply. The result is compared and analyzed in MATLAB/Smulink. Harmonics substance of the source current has been figured and contrasted for the diverse cases with exhibit the impact of consonant extraction circuit on the symphonious pay normal for the hybrid active power filter.

Keywords*: (AAN) Artificial Neural Network Controller,(HAPF) Hybrid Active Power Filter, MATLAB, (APF) Active Power Filter.

I. INTRODUCTION

In customary life, there are nonlinear burdens that create harmonics streams. The power electronics gadgets nonlinearity and the higher exchanging frequency are generally upright for these harmonics currents which can connect destructively with an extensive variety of energy framework equipment, control frameworks, circuit security, and other consonant delicate loads. As a reason of the harmonics can stumbling of source supplies, overheat building wirings and can bring about disappointment of aggregate hardware. There are various strategies to diminish the impact of harmonics; for the most part harmonic filter strategy is utilized. The active power filter to alleviate harmonics issues [1],[2].

At that point, the application and ideas of active power filters have turned out to be more well known and have pulled in incredible consideration [3],[4].

Idea of consonant alleviation system in which, reference current is produced by utilizing the twisted waveform, numerous proposals have been created like momentary receptive power hypothesis (p-q hypothesis), d-q hypothesis, neural system and so on. Essentially active filter have some hindrance, on of the principle issue is active filter is utilized for current related issue so lessen this issue utilizing hybrid power filter. In this paper display the issue of energy quality, issue because of harmonics, harmonics filter procedure and thought regarding hybrid filters. The total harmonics distortion is the main problem in the power system network the total harmonic distortion should be less than 5% of the lave as for the IEEE 519 harmonics standard.

To defeat this issue Active Power Filter (APF) is acquired impact. Active power filter is a active and adaptable answer for the moderation of consonant current due to their minimized size, no prerequisite of tuning and stable operation. Active power filter goes about as consonant current source to give vehement outcome to repay to harmonics streams and also receptive power. It has the ability to infuse consonant current into the air conditioner framework with a similar plentifulness yet in inverse stage of the heap [5]. As the HAPF is unpredictable with practical parameter control, the hybrid active power filter (HAPF) has been ideal in the subject of harmonics arrangement. Hybrid active power filter (HAPF) gives the solid mix of passive and active filter.

II. HYBRID ACTIVE POWER FILTER

Hybrid power filter is the combination of the active power filter and the passive power filter. The hybrid power filter with different topologies can help to mitigate the harmonics and the reactive power compensation. The hybrid power filter is mainly classified in three categories which is shown in fig 1

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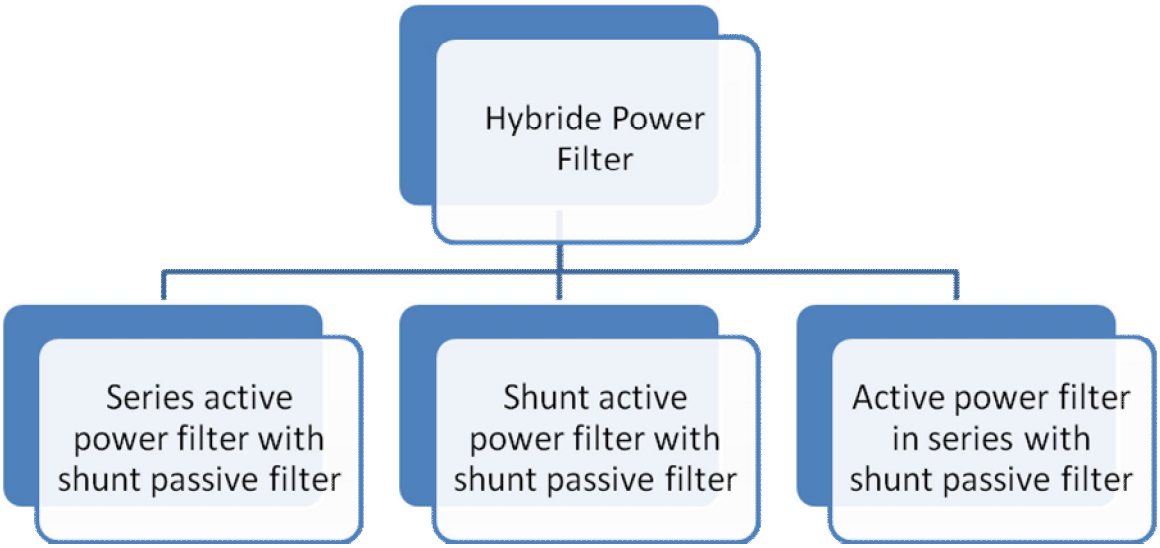

Fig.1 – Block Diagram of Classification of Hybrid Power Filter.

III. PRAPOSED SYSTEM MODEL

As the HAPF is unpredictable with practical parameter control, the hybrid active power filter has been ideal in the subject of harmonics arrangement. Hybrid active power filter (HAPF) gives the solid mix of passive and active filter. Which suggests the upsides of both and takes out the short-comes of every one appeared in. The basic block diagram of hybrid active power filter is shown in fig.2. In the hybrid active power filter the active filter is controlled by the AAN based controller. The active power filter is shunted with the passive filter. The active filter is used which is IGBT active power filter are used.

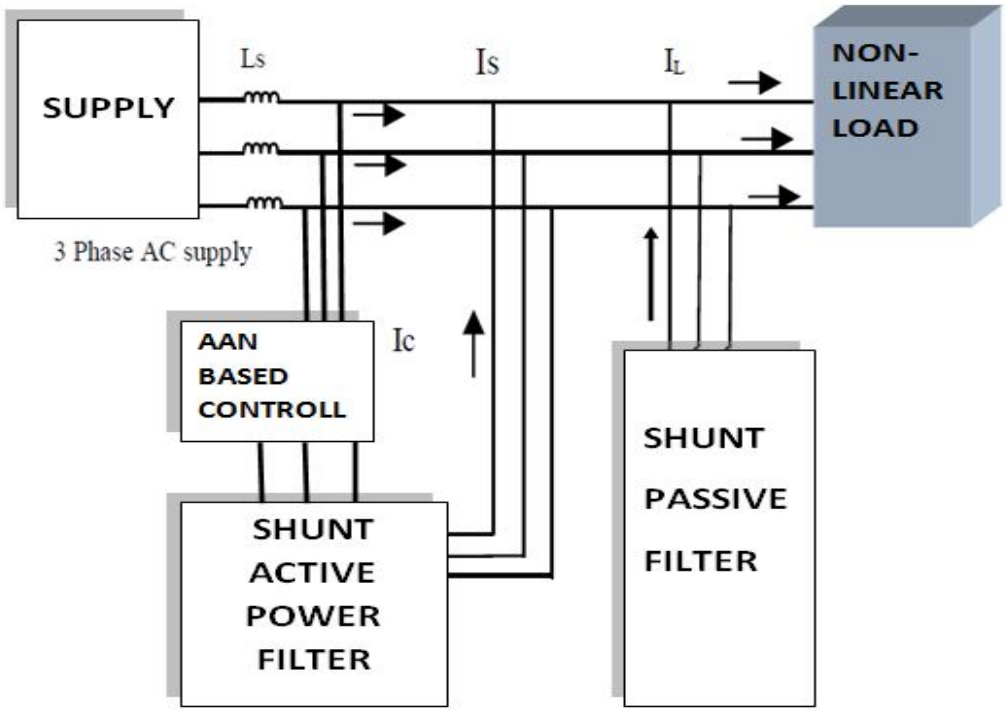

Fig.2 – Block diagram of shunt hybrid active power filter with passive filter.

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Precision of this hybrid active power filter is relying on the estimation of consonant current and era of reference current. In this paper, a three stage three wire neural system controlled shunt mixture dynamic power filter is proposed [6], [7], [8]. To make the shunt dynamic power channel show more dynamic and powerful in nature in this paper an ANN controller has been utilized to encourage the count of reference streams. ANN controller is utilized to produce central from non-perfect voltage source. The removed central streams are then subtracted from source current to assess the reference flag i.e. harmonics current. The proposed controller makes them learn with high precision and straightforward engineering and it can be effectively connected for harmonics sifting under different power framework working conditions. This paper, thusly, presents a hybrid power filter(HPF) utilizing neural system controller to control the harmonics under various non-sinusoidal and lopsided source/stack conditions for its execution. The schematic circuit diagram of the hybrid active power is shown in fig.3.

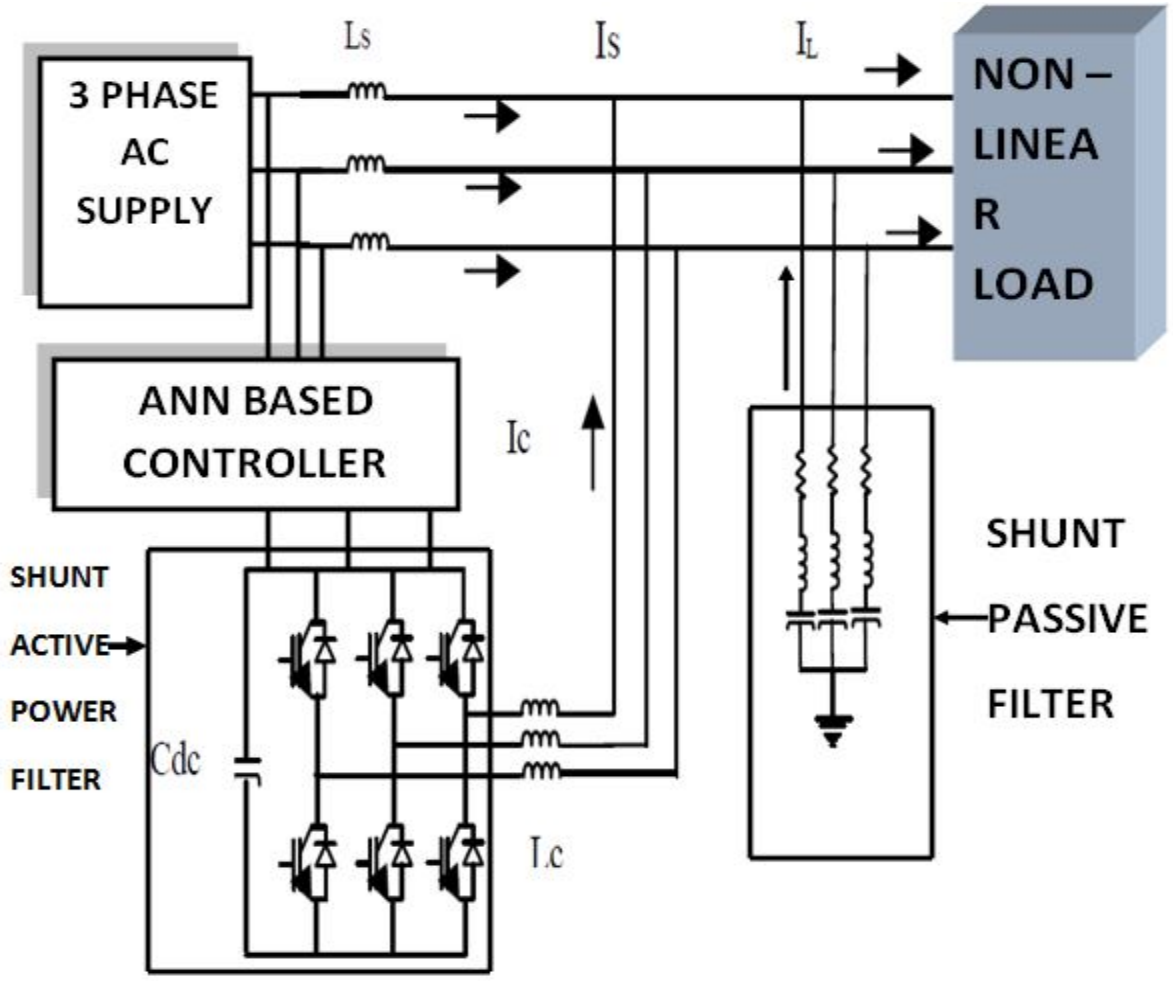

Fig.3 – Schematic diagram of shunt hybrid active power filter with shunt passive filter.

IV. PROPOSED TOPOLOGY

Three stage three wire hybrid active power filter is utilized as model appeared in figure 4. Shunt active power filter is utilized to create pay current in inverse stage. Control circuit for APF is proposed as an IGBT based three-stage voltage source inverter with DC stockpiling capacitor for better remuneration of non-straight lopsided/adjusted burdens. Active power filter has two diverse control plans; one is Neural Network Controller(ANN) that records for reference current era and second PI controller for DC voltage regulation .ANN involves three versatile straight neurons to separate the major parts of the three stage voltages from non-sinusoidal supply [9]. The capacitors are intended to confine the dc voltage swell to a determined esteem, normally 1 to 2 %. For this situation the capacitor ought to be intended for the most pessimistic scenario. Since the dynamic filter will work in a few modes (adjusted or lopsided load), then the infusion of pay current is done so as to invalidate or relieve the consonant streams. Infusion of this pay current gives enhanced power quality. The execution of the dynamic power filters is reliant all things considered upon the

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technique utilized for the count of reference current.

A. Designing of Hybrid power filter

The prerequisite of responsive power is must for planning of Hybrid Power Filter(HPF). The proposed control plot creates the reference pay current for the dynamic power separating with low request sounds and VAR being dealt with, by the inactive tuned channel [10], [11], [12]. Accordingly, no consonant reverberation happens and no consonant current streams in the supply. Taking after conditions can be utilized for planning inactive or passive filter

Let VAR prerequisite of load is $(VAR)_L$ so VAR provided by passive filter is

$$(VAR)_S = \frac{(VAR)_L}{3} \quad \text{..... (1)}$$

Capacitance, inductance and resistance of the detached or passive filter component can be figured as

$$C = \frac{(VAR)}{\omega V^2} \quad \text{..... (2)}$$

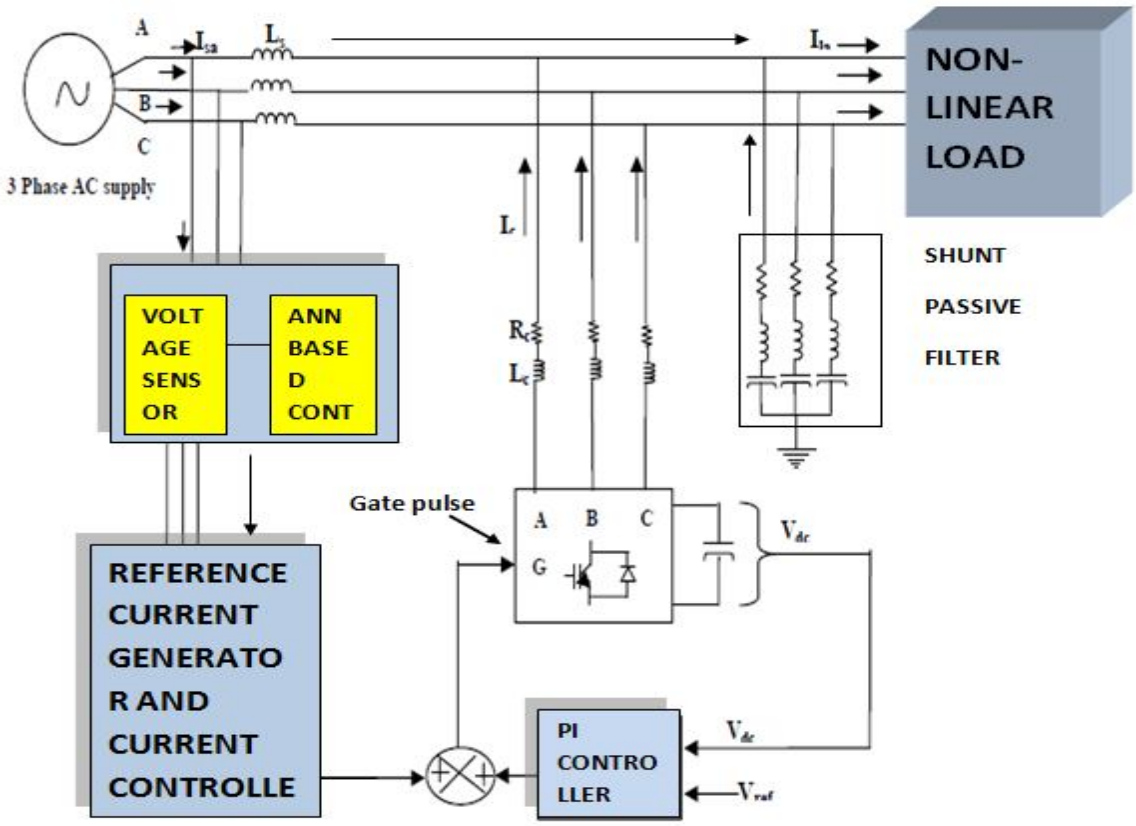

Fig.4 – Proposed Topology for Shunt Active Power Filter.

$$L = \frac{1}{C\omega^2} \quad \text{..... (3)}$$

$$R = \frac{\omega L}{Q} \quad \text{..... (4)}$$

Where, Q is the Quality component. Estimation of R, L and C fluctuates with various estimations of VAR and Q. After further examination taking after condition is gotten

$$B_p = \frac{1}{Q} \quad \text{..... (5)}$$

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Where, BP is the transmission capacity of the inactive channel. With high estimation of Q the data transfer capacity is limited thusly it is hard to acquire the tuning. The aggregate impedance of framework is given by the condition

$$Z = \frac{Z_S Z_7 Z_5}{Z_5 Z_7 + Z_5 Z_S + Z_7 Z_S} \quad \text{…….. (6)}$$

Where, Z_S is the source impedance and Z_5 and Z_7 are the fifth and seventh tuned latent filter impedances.

B. Control Strategy

The fundamental capacity of control plan is appeared in figure. 6 to keep up supply current waveform sinusoidal, recognizable proof of harmonics substance, direction of DC voltage and controlling plan of hybrid shunt active power filter (HSAPF) is necessary which gives repaying current to the power framework and in addition supplies consonant streams to the three stage non-direct load at a similar moment. For the correct reaction of APF the extraction of major segment of current from non-sinusoidal information, reference current era, DC voltage control and infusion of pay streams are fundamental errands [13]. These errands can be accomplished as it were by utilizing different controlling plans. The circuitous technique for current/voltage sensors is utilized. The three stage unit voltage vectors (v_{sa}, v_{sb}, v_{sc}) are gotten from the supply voltages. These unit vectors, when multiplied with reference supply current (I^*_{sm}), result in three stage reference supply streams (I^*_{sa}, I^*_{sb}, I^*_{sc}). The reference supply streams and detected supply ebbs and flows (I_{sa}, I_{sb}, I_{sc}) are the contributions for the beat generator, which produces the terminating beats for the gating signs to the IGBT's of the dynamic power filter[14], [15]. Hysteresis current control is a technique for controlling a voltage source inverter so that the yield current is produced which takes after a reference current waveform.

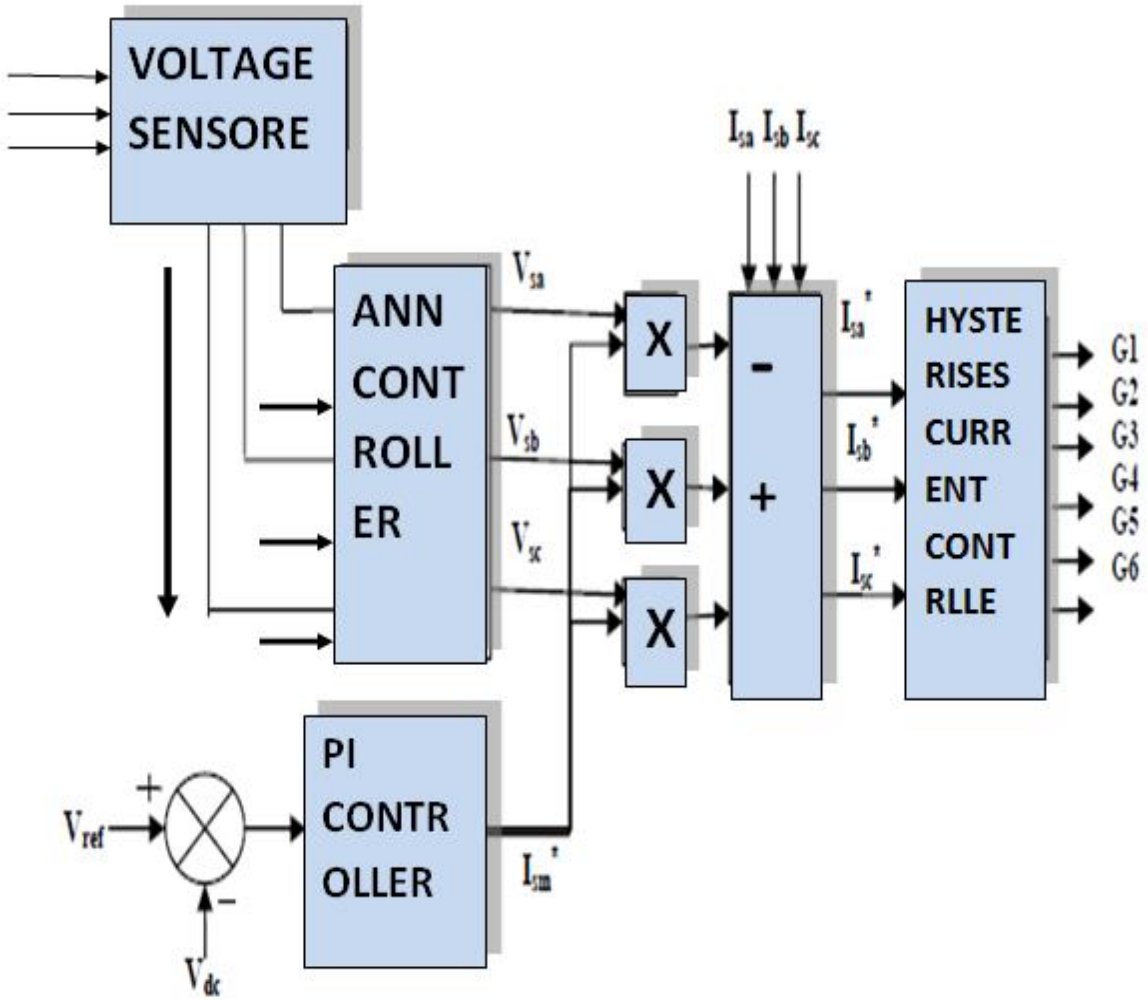

Fig. 6 – The Block Diagram of Control Strategy of Shunt Hybrid Active Power Filter.

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C. Neural Network Controller

One critical issue that surveys and assesses the nature of the conveyed power is the estimation or, then again extraction of central segments from mutilated current or voltage waveforms. With a specific end goal to give superb power supply power, it is basic to precisely gauge or concentrate time changing essential segments, both the extent and the stage edge, to alleviate harmonics part utilizing active power filters. There is harmonics estimation system announced in light of Artificial Neural Networks (ANN) controller. ANN is observed to be most worthwhile so thusly ANN utilized as a part of this work. More often than not, a low pass filter is used for isolating central segment from voltage which is wasteful in genuine conditions proposed before. Also, it has issues identified with exact stage and pick up tuning and three extra present sensors are required for detecting load streams. We realize that the choice of specific request and cut-off recurrence assumes a noteworthy part in planning a channel. Henceforth, in the proposed technique, a neural system is utilized for removing basic segments from each period of source streams rather than stack streams for non-perfect mains supply and coming about

genuine power because of basic segments of ebbs and flows is figured. The engineering of proposed ADALINE neural system has two layer (info and yield) arrange having n-inputs and a solitary yield appeared in figure 7.

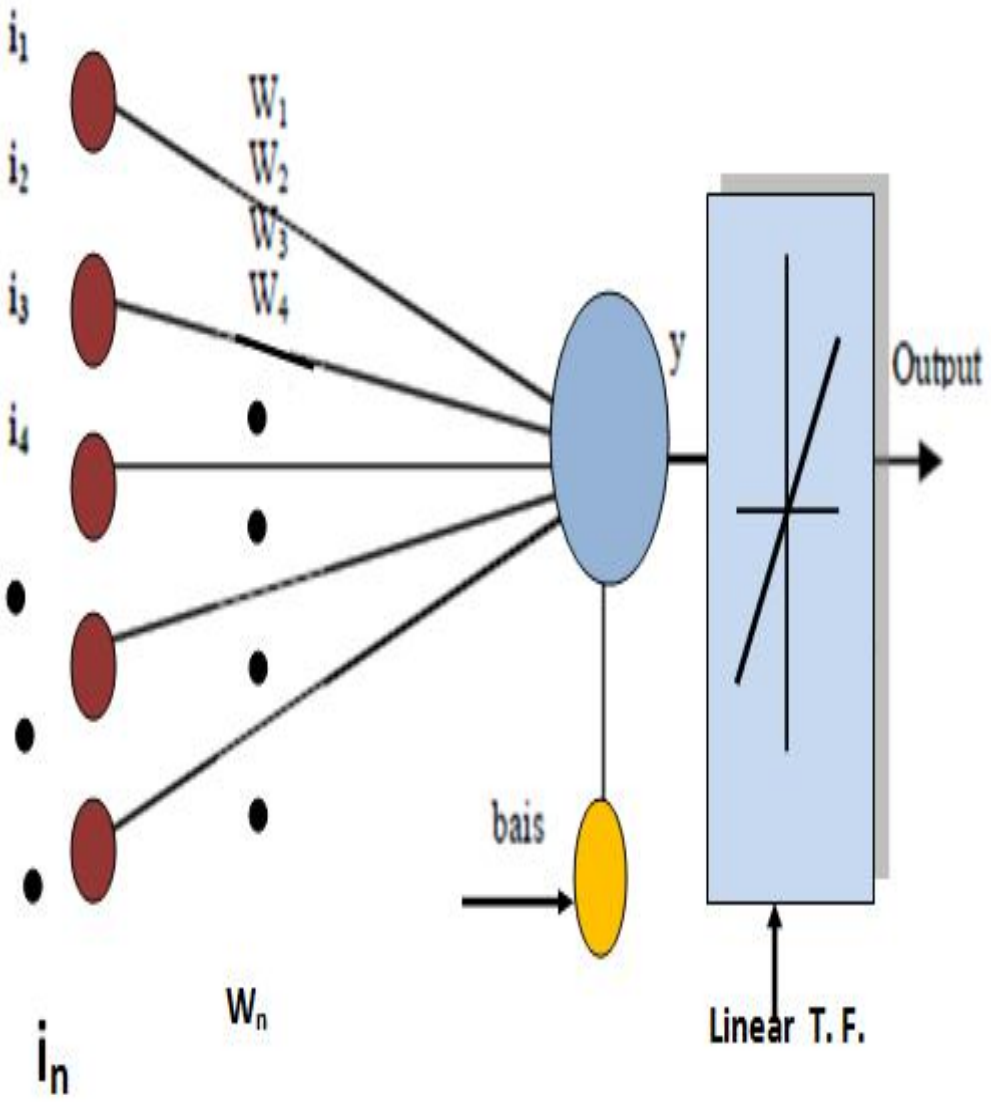

Fig.7 – Inter Block of Proposed Artifitial Nular Network.

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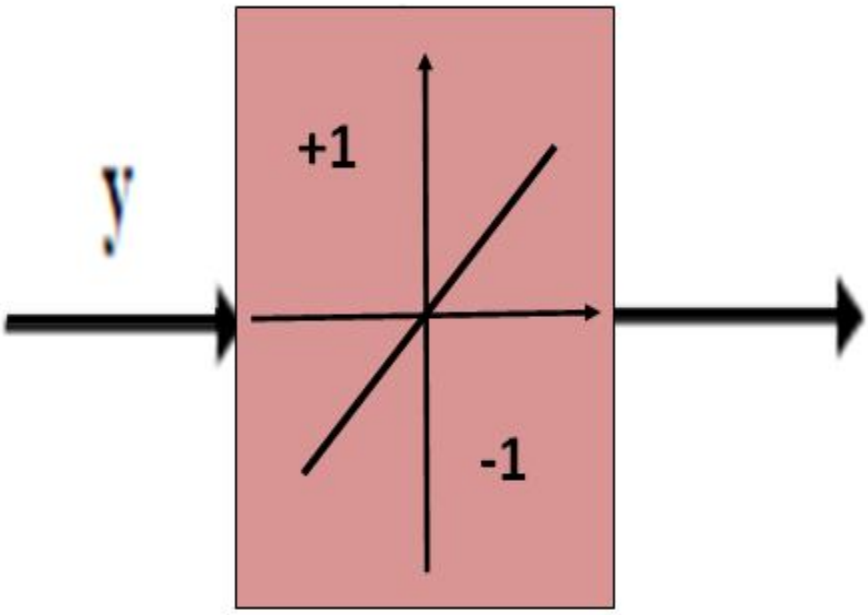

Fig .8 - Input/output relationship of purlin transfer function

The fundamental pieces of this system are info flag postpone vector, a purelin exchange work, weight framework and predisposition is appeared in figure 8. The information yield relationship is communicated as:

$$Y = \prod_{n=1}^{61} \omega_n * i_n + b. \quad \text{.....(7)}$$

Where "b" is inclination, "w" is weight, and "i" is the contribution to the NN. The contribution to the system is a time delayed arrangement of the flag whose major part is to be extricated. The length of this postpone arrangement is 61, which has been chosen considering expected most extreme twisting and unbalance in 3-stage input flag. The contribution of the ANN framework is supply voltage and current and the yield of the framework is APF reference current. The weight modification is performed amid the preparation procedure of the ADALINE utilizing Widrow-Hoff delta administer [16]. The mean square mistake between craved yield and the genuine yield was diminished to 3.2e-5 by tedious preparing with the learning rate of 0.0006.

D. Corresponding Integral Controller

PI controller calculation includes two separate parameters; the Proportional and the Integral. The Corresponding worth decides the response to the present blunder; the Integral decides the response in light of the whole of late blunders. A correlation of the normal and the reference estimations of the dc transport voltage for the shunt AF brings about a voltage blunder, which is encouraged to a corresponding essential (PI) controller and the yield of the PI controller is duplicated by the mains voltage waveform V_{sa}, V_{sb}, V_{sc} with a specific end goal to acquire the supply reference streams i_{sa}*, i_{sb}*, i_{sc}*.

A PI controller used to control the DC-transport voltage is appeared in Figure 9 whose exchange capacity can be spoken to as

$$H(S) = K_p + \frac{K_i}{S}. \quad \text{..... (8)}$$

Where, k_p is the relative steady that decides the dynamic reaction of the DC-transport voltage control, furthermore, k_i is the mix consistent that decides it's settling time.

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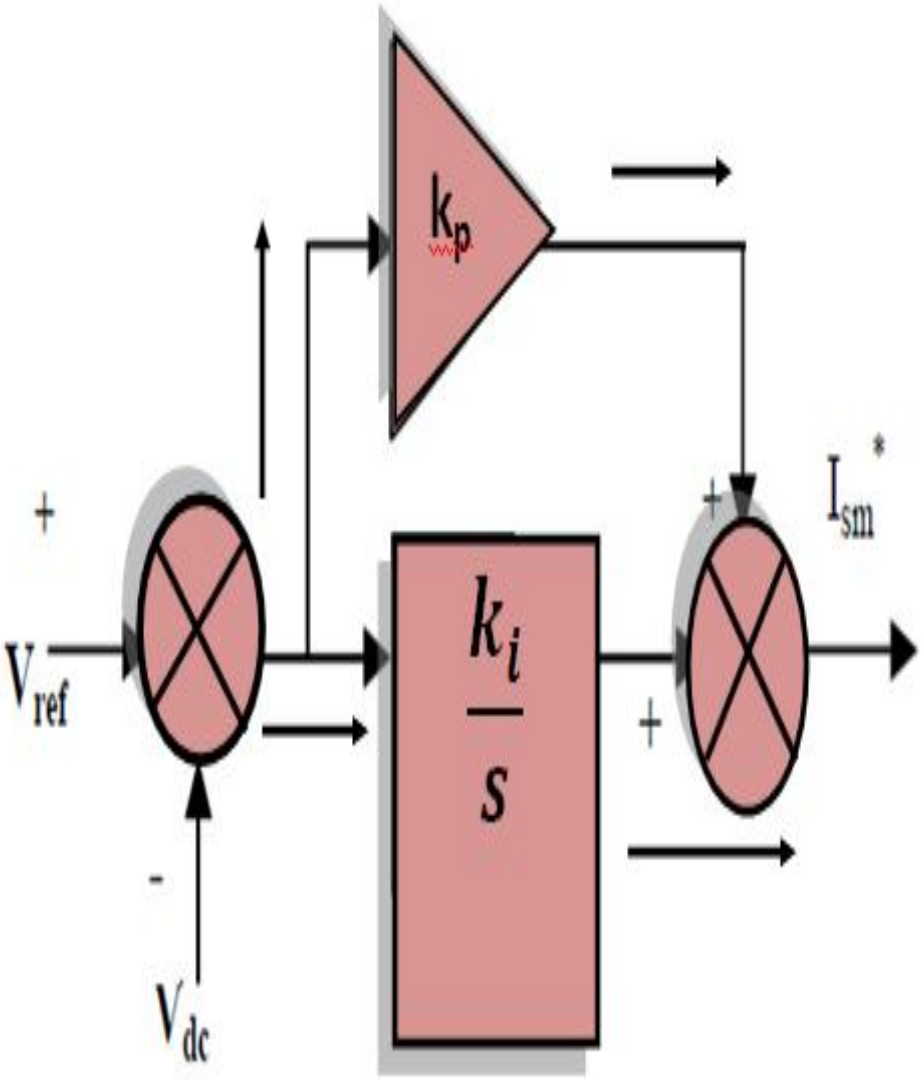

Fig .9 - PI controller for DC-bus voltage control

It can be noticed that if k_p and k_i are expansive, the DC-transport voltage control is prevailing, and the steady-state DC-transport voltage blunder is low. On the hand, if k and ki are little, the genuine power unbalance gives nearly nothing impact to the transient execution. Along these lines, the best possible determination of k_p and k_i is basically imperative to fulfil previously mentioned two control exhibitions. The processed three-stage supply reference streams are contrasted and the detected supply ebbs and flows what's more, are given to a hysteresis current controller to produce the changing signs to the switches of the shunt AF which makes the supply streams take after its reference esteems.

V. RESULT

The proposed model is subjected in different cases which are first with ideal supply three phase voltage and second one is distorted three phase supply voltage. Filter start for this proposed model at 0.3 sec. After filtered the result of three phase ideal supply, and three phase distorted supply voltage is given below. After 0.3 sec when the filter is start filtering the waveform is getting smother and the total harmonics distortion for the ideal three phase supply is about 8% and for the distorted three phase supply voltage is about 5%.

Case 1 result when subjected with ideal three phase supply source.

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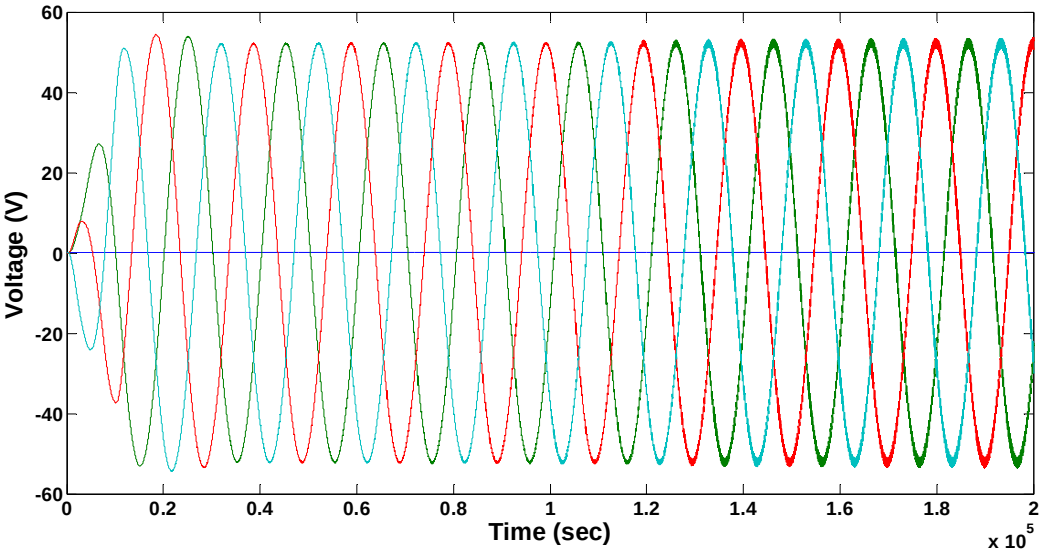

Fig.10 The Three Phase Ideal Supply Source Voltage.

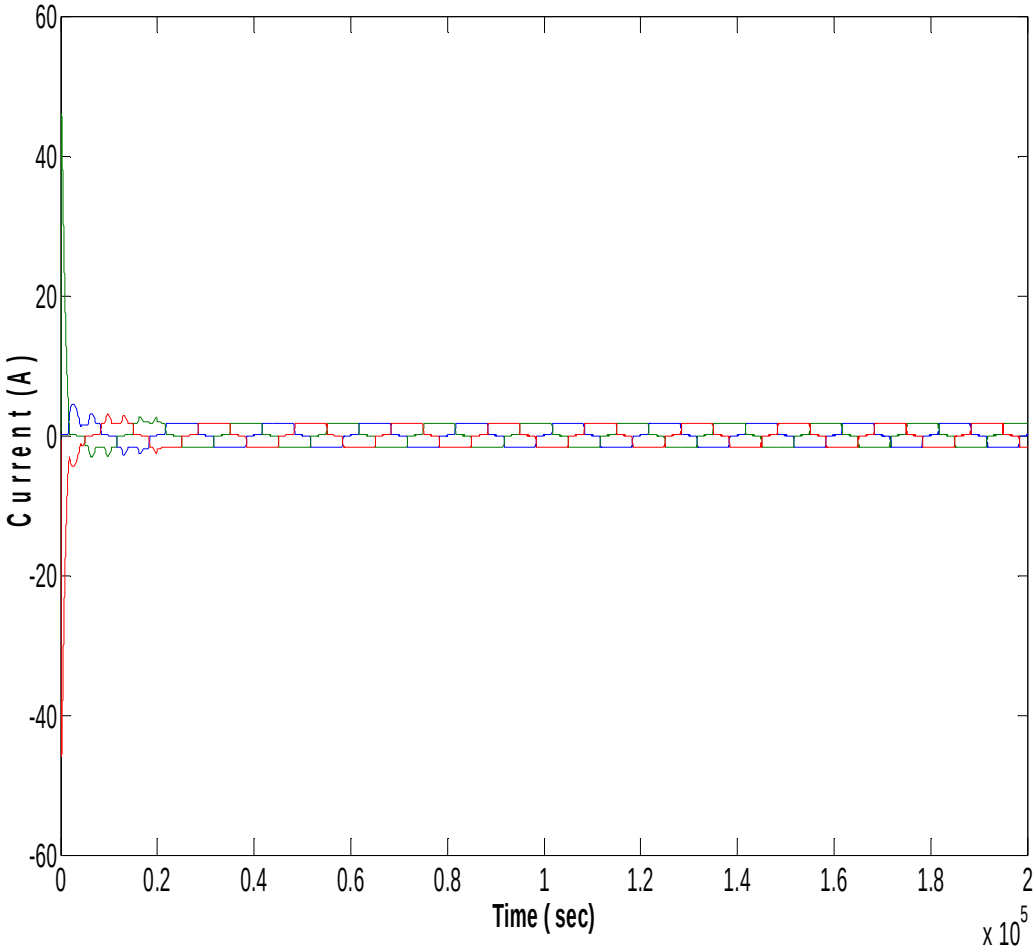

Fig. 11 The Load Current Waveform

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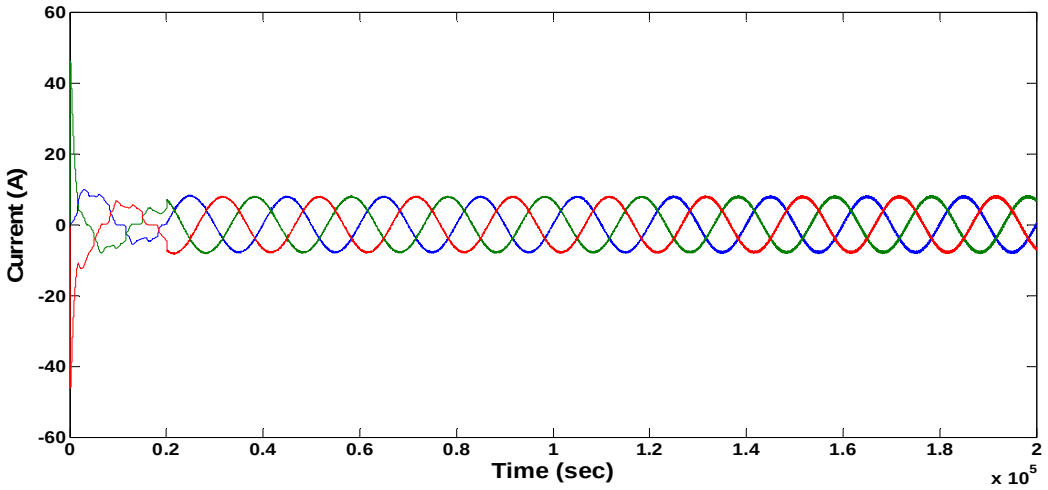

Fig. 12 The Source Current Waveform.

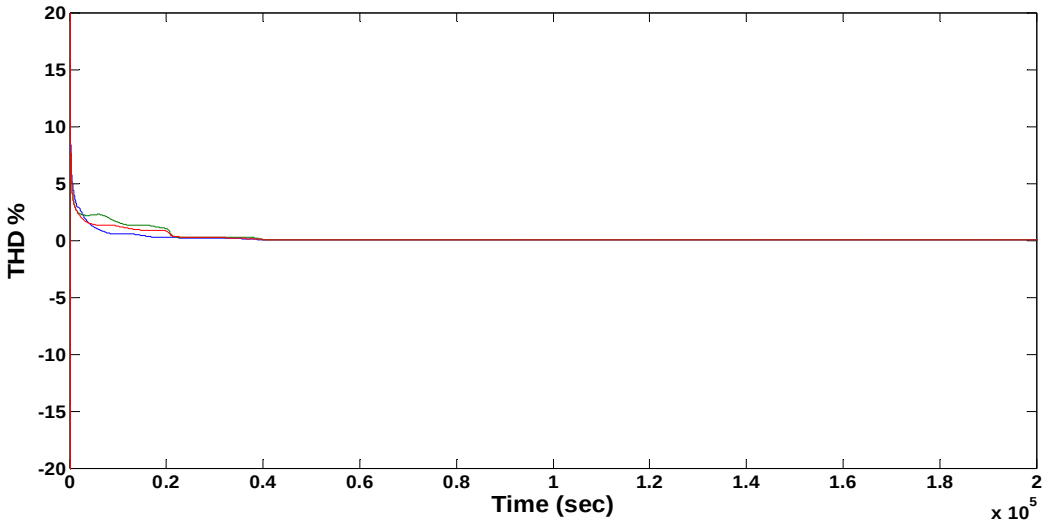

Fig.13 The Total Harmonics Distrotion Waveform in %.

Case 2 When subjected to distorted supply voltage.

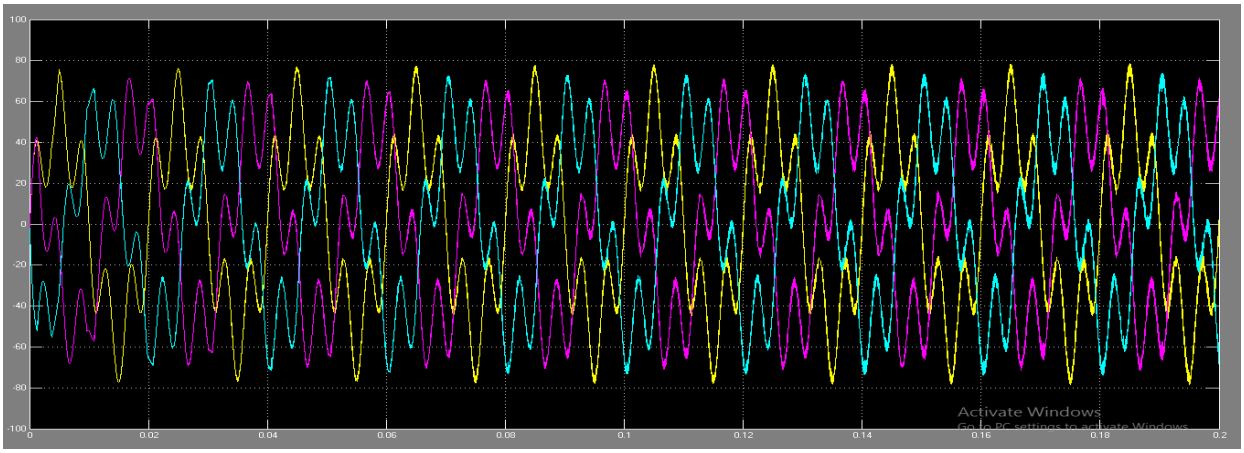

Fig.14 The Distorted Supply Voltage Source Voltage Wave- form.

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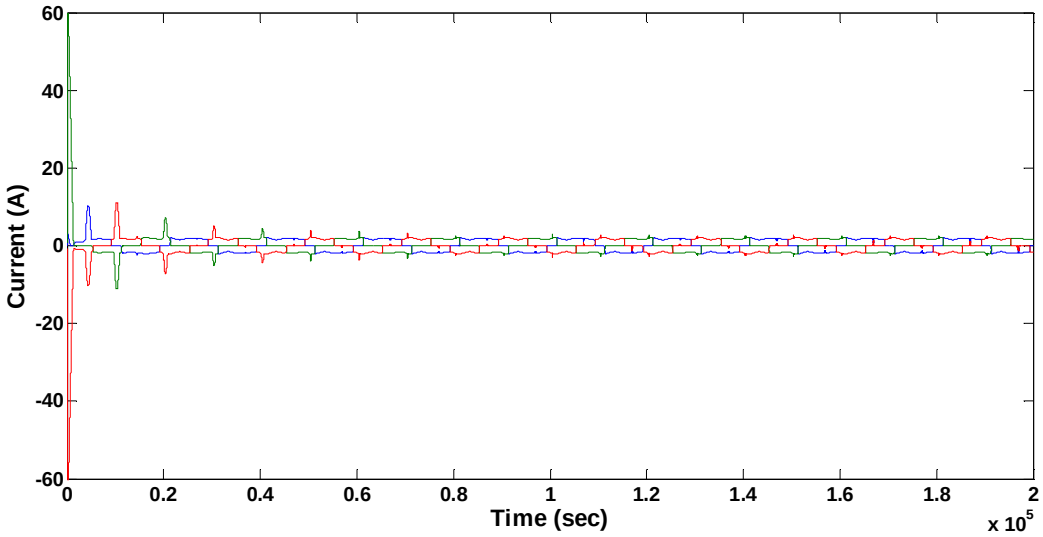

Fig. 14 The Load Current Waveform.

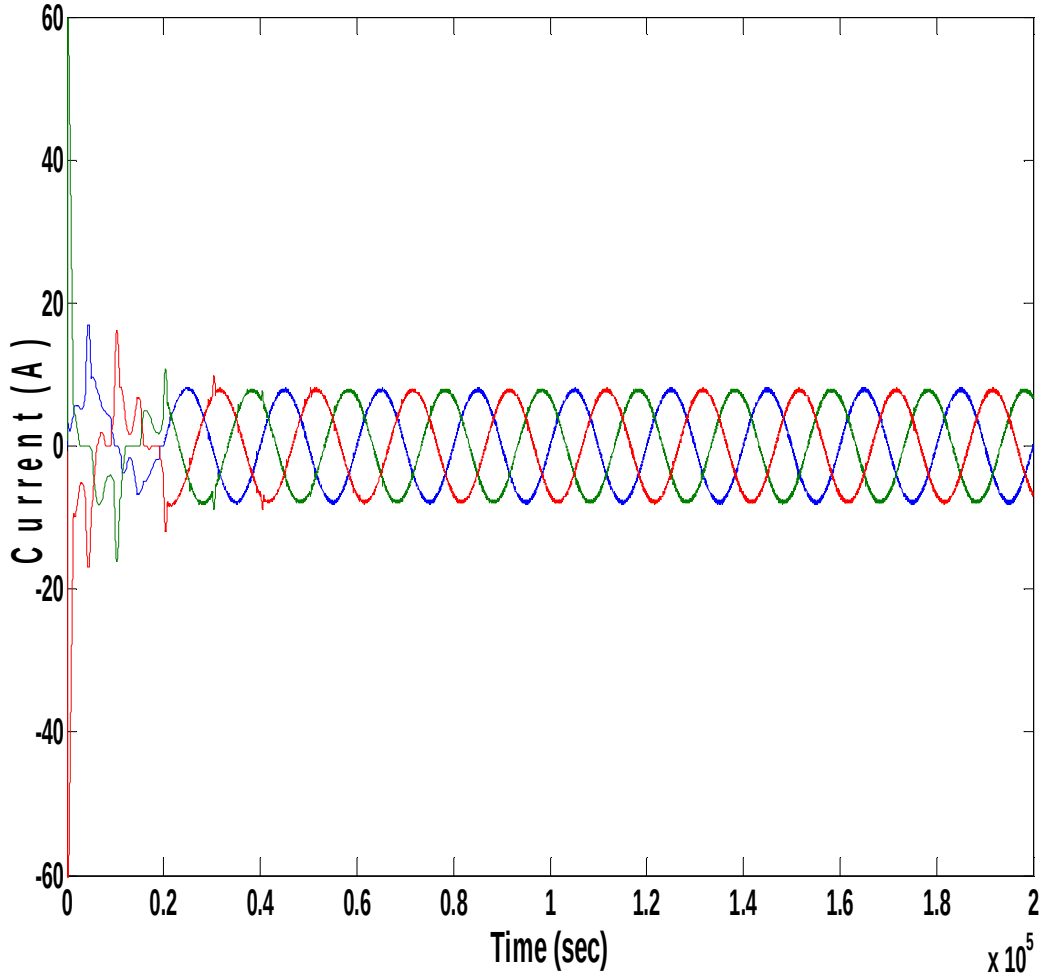

Fig. 15 The Souece Current Wave form.

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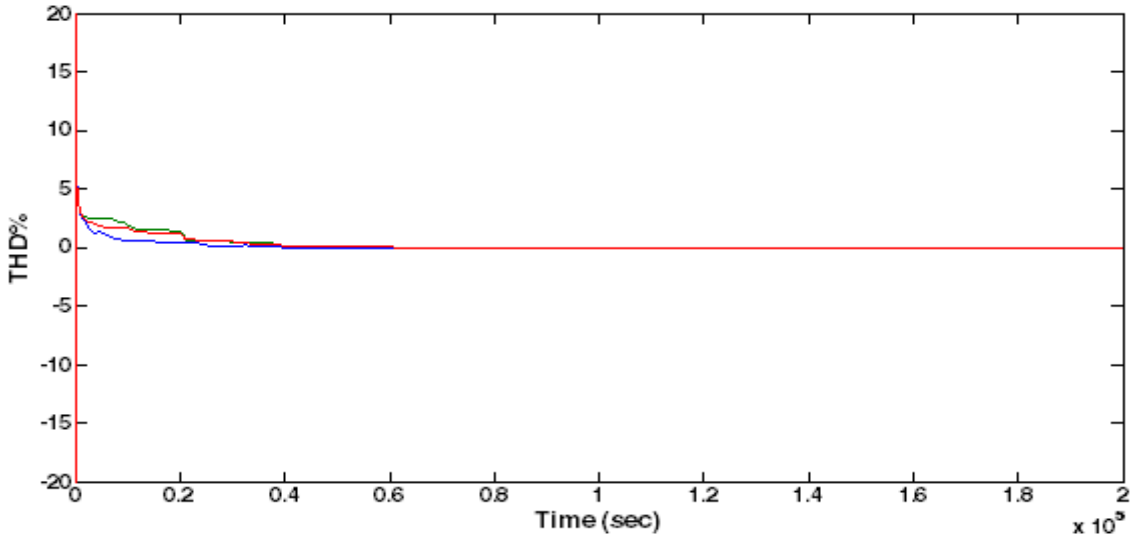

Fig. 16 The Total Harmonics Distrotion in %.

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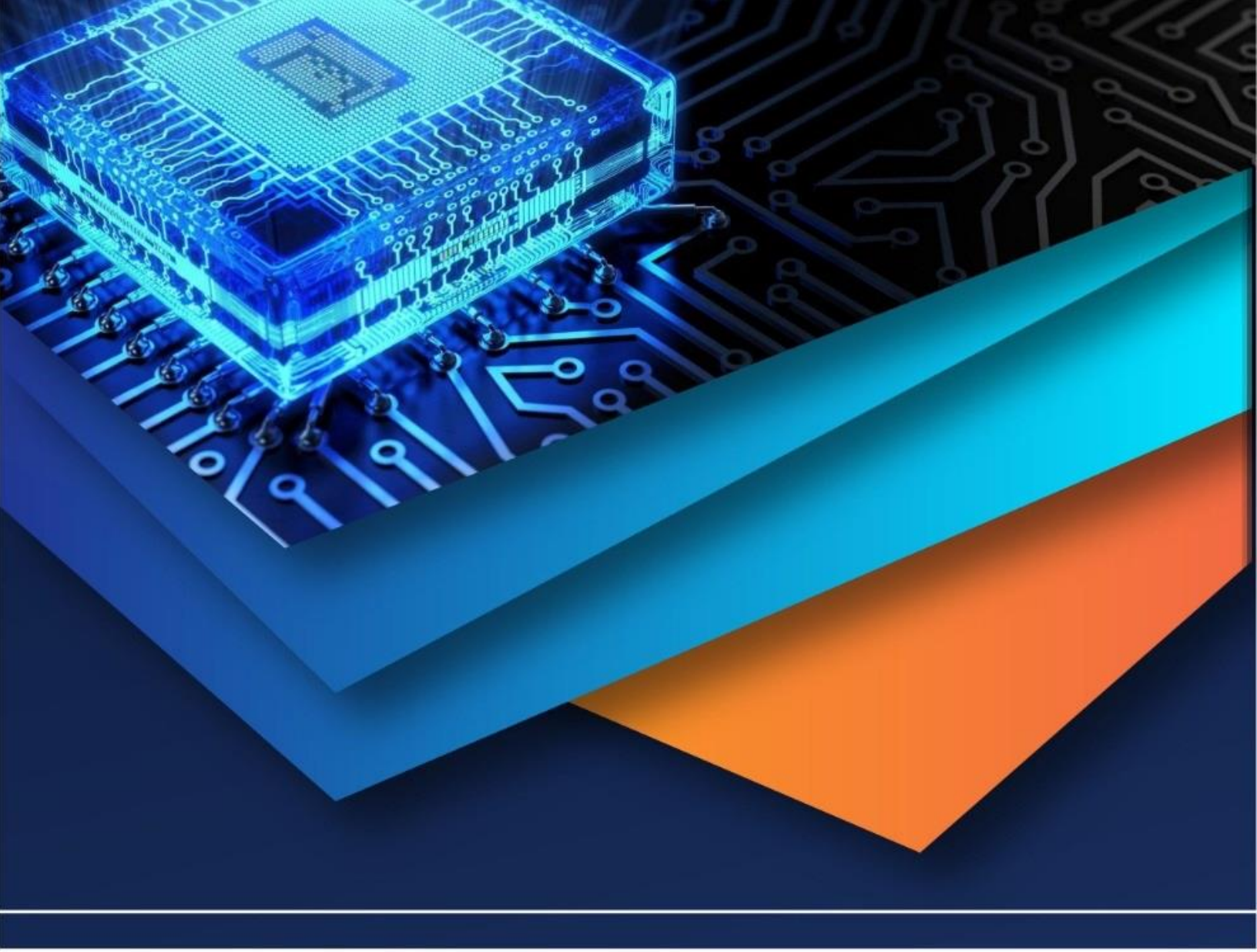

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