JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 1, 2022, p. 981 - 989
https://publishoa.com
ISSN: 1309-3452

Improvement of Power Quality Using Hysteresis Current Controller by Shunt Active Power Filter

[1]B. Divya jeswini, [2]R. Shasidhar, [3]K. C. Venkataiah

[1]Assistant Professor, Dept. of EEE, Ashoka Women's Engineering College, Kurnool
[2]Assistant Professor, Dept. of EEE, Ashoka Women's Engineering College, Kurnool
[3]Assistant Professor, Dept. of EEE, Ashoka Women's Engineering College, Kurnool

ABSTRACT

One of the main power quality concerns currently is the existence of harmonics. Shunt active power filters are widely applied in power distribution grids to mitigate current harmonics and compensate the reactive power. In this paper the instantaneous reactive power theory is used to detect reference compensation current for the controller of the shunt active filter and a hysteresis current controller is used to synthesize it precisely. Hysteresis current controller is one of the simplest current control methods and the most popular one for active power filter applications, but it suffers from an uneven switching frequency, to overcome this disadvantage a novel fuzzy hysteresis current controller is being used. The proposed controller is characterized by simplicity because of reducing the size of calculations that makes it acting faster and doesn't rely on the load parameters. The system was modeled and simulated using MATLAB/SIMULINK. The results of simulation are presented and discussed they show the effectiveness of the proposed fuzzy hysteresis controller in improving the PWM performance and thus improve the shunt active power filter performance.

Key Words: Matlab, Fuzzy, Shunt Active Power Filter, Simulink, Hysteresis

1. Introduction

Ideally an electricity supply should fixedly show a perfectly sinusoidal voltage signal at every location. However, for a number of reasons, utilities often find it difficult to maintain such desirable condition. For example, the widespread use of nonlinear devices likes (microprocessor, variable speed drives, uninterrupted power supplies and electronic lighting) which have become used on a large scale. These modern power electronic devices draw a significant amount of harmonics from the electrical grid; these non-sinusoidal currents interact with the impedance of the power distribution lines creating voltage distortion at the point of common coupling (PCC) that can affect both the distribution system equipment and the user loads connected to it. As a result, the utilities obliged to reduce the total harmonic distortion (THD) at the point of common coupling below 5% as given in the IEEE 519-1992 harmonic standard. This can be achieved through the use of the harmonic filters whether passive or active filters.

The passive filtering is the simplest classical solution to mitigate the harmonic distortion, these filters consisting of R, L and C elements connected in various configurations. Although simple, these filters have many defects such as fixed compensation, bulky size and resonance so these filters may not be able to achieve the desired performance thus we need to use dynamic and adjustable devices to mitigate the power quality problems such as active power filters.

Active power filters are considered the most ideal solutions to the many of power quality problems such as harmonics, reactive power, regulate terminal voltage, flicker and improve voltage balance in three phase systems. Shunt active power filter is the most important configuration and widely used in active power line conditioners applications. It automatically adapts to changes in the grid and load fluctuations, can compensate for several harmonic orders and eliminating the risk of resonance between the filter and the grid impedance

Shunt active power filter is the most important configuration and widely used in active power line conditioners applications. It automatically adapts to changes in the grid and load fluctuations can compensate for several harmonic orders and eliminating the risk of resonance between the filter and the grid impedance.

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 1, 2022, p. 981 - 989
https://publishoa.com
ISSN: 1309-3452

2. Power Quality

The electric power industry comprises electricity generation (AC power), electric power transmission and ultimately electric power distribution to an electricity meter located at the premises of the end user of the electric power. The electricity then moves through the wiring system of the end user until it reaches the load. The complexity of the system to move electric energy from the point of production to the point of consumption combined with variations in weather, generation, demand and other factors provide many opportunities for the quality supply to be compromised. Both electric utilities and end users of electric power are becoming increasingly concerned about the quality of electric power. The term power quality has become one of the most prolific buzzwords in the power industry.

The contemporary container crane industry, like many other industry segments, is often enamoured by the bells and whistles, colourful diagnostic displays, high speed performance, and levels of automation that can be achieved. Although these features and their indirectly related computer-based enhancements are key issues to an efficient terminal operation, we must not forget the foundation upon which we are building. Power quality is the mortar which bonds the Foundation blocks. Power quality also affects terminal operating economics, crane reliability, our environment, and initial investment in power distribution systems to support new crane installations.

POWER QUALITY CAN BE IMPROVED THROUGH:

- Power factor correction,
- Harmonic filtering,
- Special line notch filtering,
- Transient voltage surge suppression,
- Proper earthing systems.

3. Fuzzy Logic

In recent years, the number and variety of applications of fuzzy logic have increased significantly. The applications range from consumer products such as cameras, camcorders, washing machines, and microwave ovens to industrial process control, medical instrumentation, decision-support systems, and portfolio selection.

To understand why use of fuzzy logic has grown, you must first understand what is meant by fuzzy logic. Fuzzy logic has two different meanings. In a narrow sense, fuzzy logic is a logical system, which is an extension of multivalve logic. However, in a wider sense fuzzy logic (FL)is almost synonymous with the theory of fuzzy sets, a theory which relates to classes of objects with un sharp boundaries in which membership is a matter of degree. In this perspective, fuzzy logic in its narrow sense is a branch of fl. Even in its narrower definition, fuzzy logic differs both in concept and substance from traditional multivalve logical systems

In fuzzy Logic Toolbox software, fuzzy logic should be interpreted as FL, that is, fuzzy logic in its wide sense. The basic ideas underlying FL are explained very clearly and insightfully in Foundations of Fuzzy Logic. What might be added is that the basic concept underlying FL is that of a linguistic variable, that is, a variable whose values are words rather than numbers. In effect, much of FL may be viewed as a methodology for computing with words rather than numbers. Although words are inherently less precise than numbers, their use is closer to human intuition. Furthermore, computing with words exploits the tolerance for imprecision and thereby lowers the cost of solution.

Another basic concept in FL, which plays a central role in most of its applications, is that of a fuzzy if-then rule or, simply, fuzzy rule. Although rule-based systems have a long history of use in Artificial Intelligence (AI), what is missing in such systems is a mechanism for dealing with fuzzy consequents and fuzzy antecedents. In fuzzy logic, this mechanism is provided by the calculus of fuzzy rules. The calculus of fuzzy rules serves as a basis for what might be called the Fuzzy Dependency and Command Language (FDCL).

Fuzzy inference is a method that interprets the values in the input vector and, based on user defined rules, assigns values to the output vector. Using the GUI editors and viewers in the Fuzzy Logic Toolbox, you can build the rules set, define the membership functions, and analyze the behaviour of a fuzzy inference system (FIS). The following editors and viewers are provided.

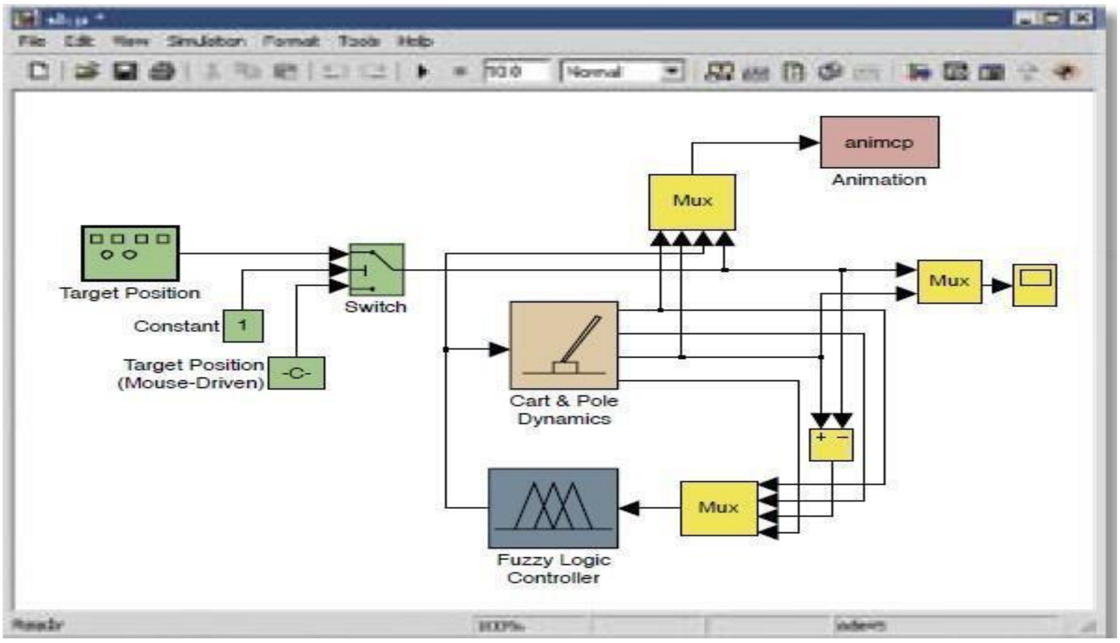


Fig. 1 demonstrates a plan of the whole planned system

4. Shunt Active Power Filter

The scheme is planned to recognize the lost person or any other required person based on the customer requirement.

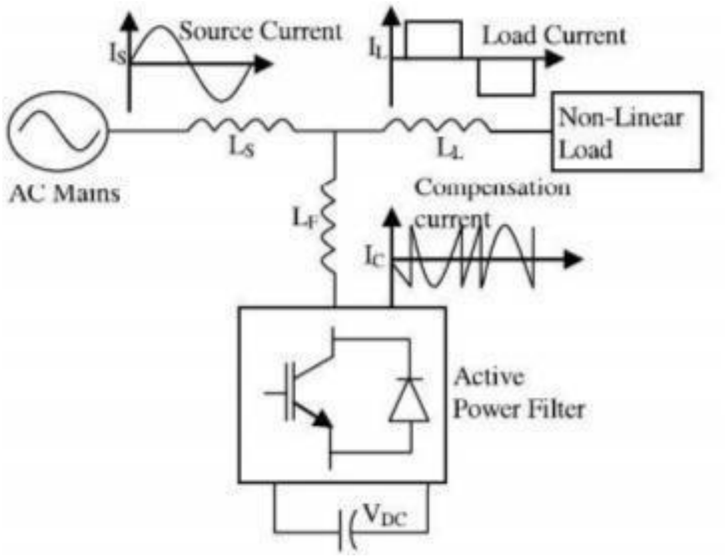
Fig. 1 demonstrates a plan of the whole planned system which shows the constituents such as the camera equipped with the internet and GPS sensor, Cloud server and Mobile phone.

The product/System consists of the cameras (1001), the camera (100) is equipped with the GPS Sensor (101), Internet (102) to know the exact location and to send the captured video/image to the cloud /centralized databases (200). The database/ cloud (201) used to store the data of the user and the data that captured from the cameras. It consists of the AI algorithms (202) to analyse the data and the deep face algorithm (203) to catch the missing person after matching with the predefined data that collected during the time of taken the complete from the user.

One the match found the data will go to the corresponding mobile phone numbers. The data may be the GPS location (301), missing person name (302). The short message service will be sent by using the IFTTT (303) technology.

Fig.2 demonstrates a representation flow of the planned scheme which displays the process flow steps.

Shunt active power filter based on voltage source converter (VSC) is an effective solution to current harmonics, reactive power and current unbalance. The basic principle of this filter is to use power electronics technologies to generate particular currents components that can cancel the current harmonic components from nonlinear load [15-17]. The performance of the shunt active filter depends on the reference compensating current detection algorithm and the current control technique used to drive the gating pulses of the active power filter switches to generate compensating current that should be injected into the power system to mitigate the current harmonics and compensate the reactive power [18-22]. The compensation characteristics of the shunt APF are shown in Fig. 1

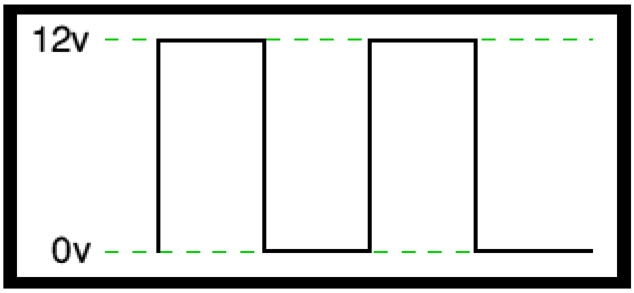


5. Pulse Width Modulation

Pulse Width Modulation (PWM) is the most effective means to achieve constant voltage battery charging by switching the solar system controller's power devices. When in PWM regulation, the current from the solar array tapers according to the battery's condition and recharging needs consider a waveform such as this: it is a voltage switching between 0v and 12v.

It is fairly obvious that, since the voltage is at 12v for exactly as long as it is at 0v, then a 'suitable device' connected to its output will see the average voltage and think it is being fed 6v - exactly half of 12v. So, by varying the width of the positive pulse - we can vary the 'average' voltage.

Similarly, if the switches keep the voltage at 12 for 3 times as long as at 0v, the average will be 3/4 of 12v - or 9v, as shown below and if the output pulse of 12v lasts only 25% of the overall time, then the average is



6. Simulation Results

This section introduces the details of simulations that have been implemented using MATLAB/SIMULINK, to shows the performance of the proposed shunt active power filter to mitigate the current harmonics and compensate reactive power in the distribution grid. Test system that was used to carry out the analysis consists of a three-phase diode bridge rectifier with RL load Connected to three-phase three wire distribution system and shunt active power filter connected to the system by an inductor L. The control strategy of the shunt active filter based on p-q theory to generate the reference compensation current, hysteresis band current controller to drive the gating signals of the shunt active filter switches and PI controller to regulate the voltage of dc side capacitor of the shunt active filter.

The values of the circuit components used in the simulation are given in Table I. The system performance was analyzed without the shunt active filter and Fig. 6 gives the details of source voltage, source current, load current, harmonic spectrum of the supply current, real and reactive power supplied by the source to the load. It is seen that line current is

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 1, 2022, p. 981 - 989
https://publishoa.com
ISSN: 1309-3452

distorted due to nonlinear load and the total harmonic distortion (THD) of the supply current is 24.44%, this current distortion resulting from the dominance of 5th, 7th, 11th and 13th harmonic spectral components. Real and reactive power supplied from the source to the load have constant values and a superposition of oscillating components, these oscillating components are related to the presence of harmonics.

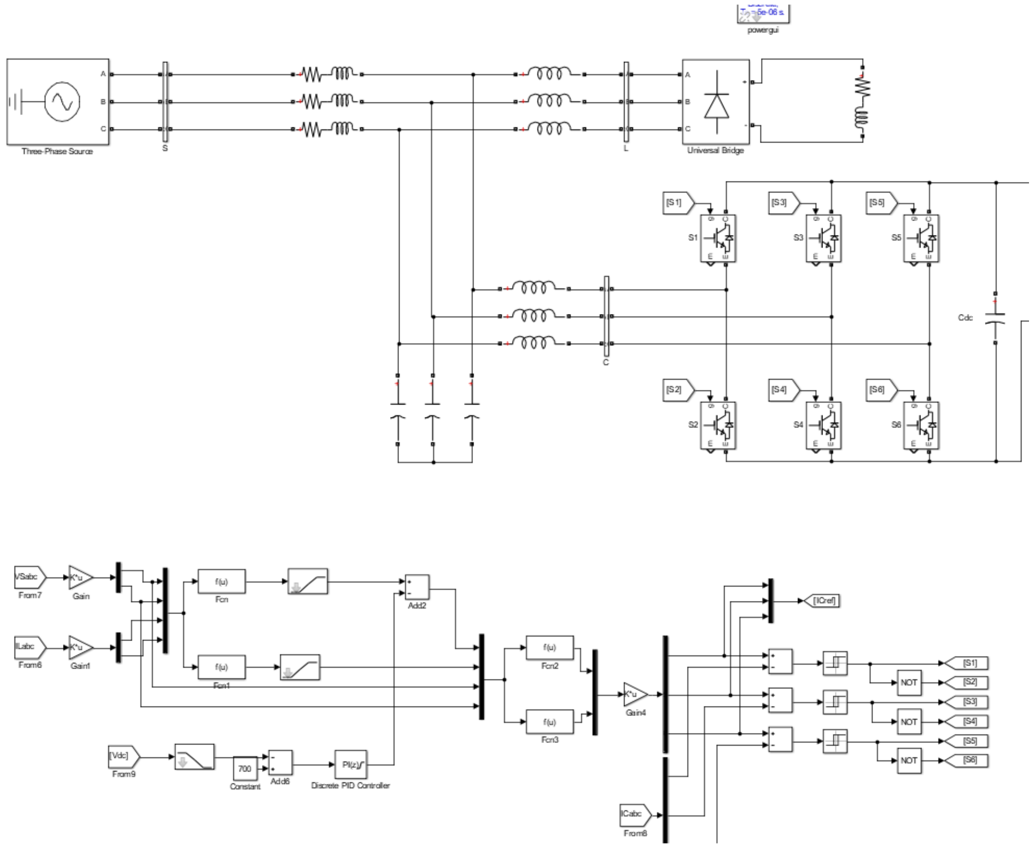
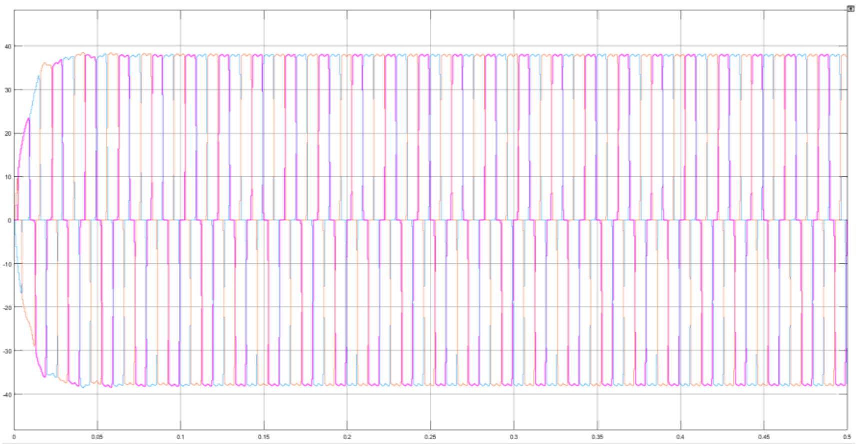


Figure 6.1. Simulation Results with Shunt Active Power Filter

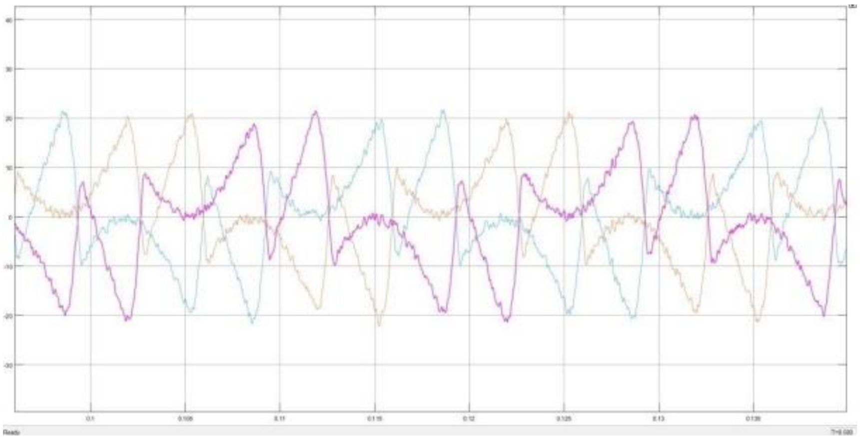
Simulation Results with Shunt Active Power Filter



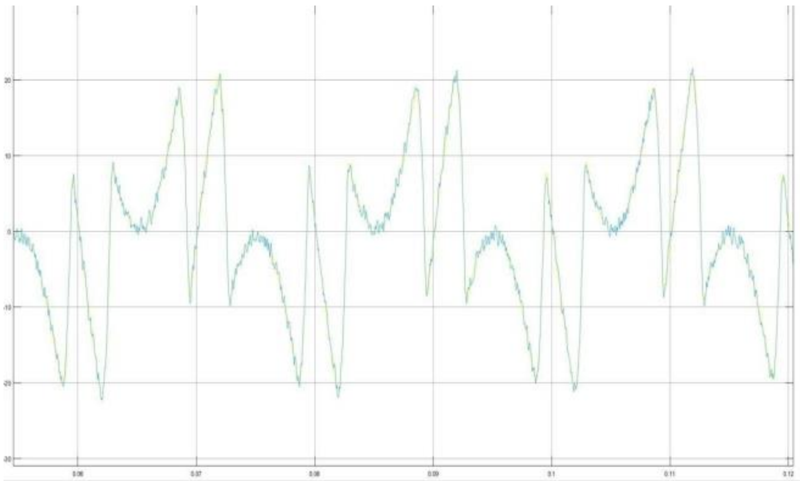
(a) Source Voltage

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 1, 2022, p. 981 - 989
https://publishoa.com
ISSN: 1309-3452

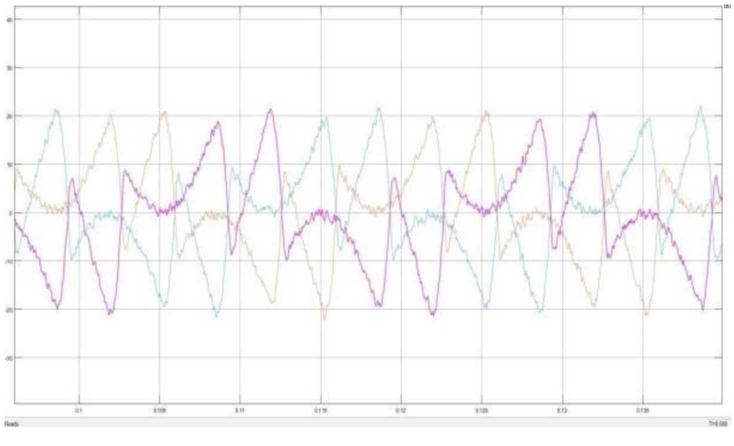
(b) Supply Current



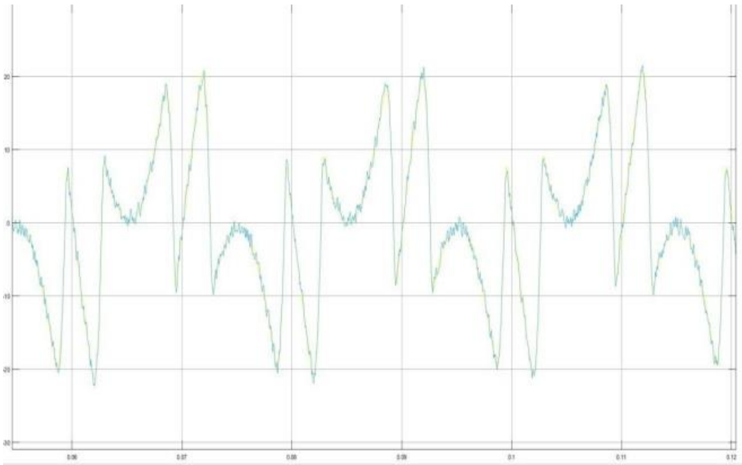
(C) Reference Current



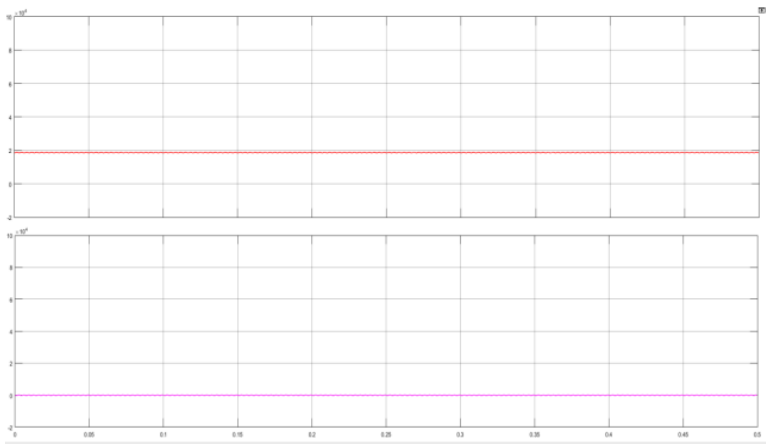
(D) Filter Current



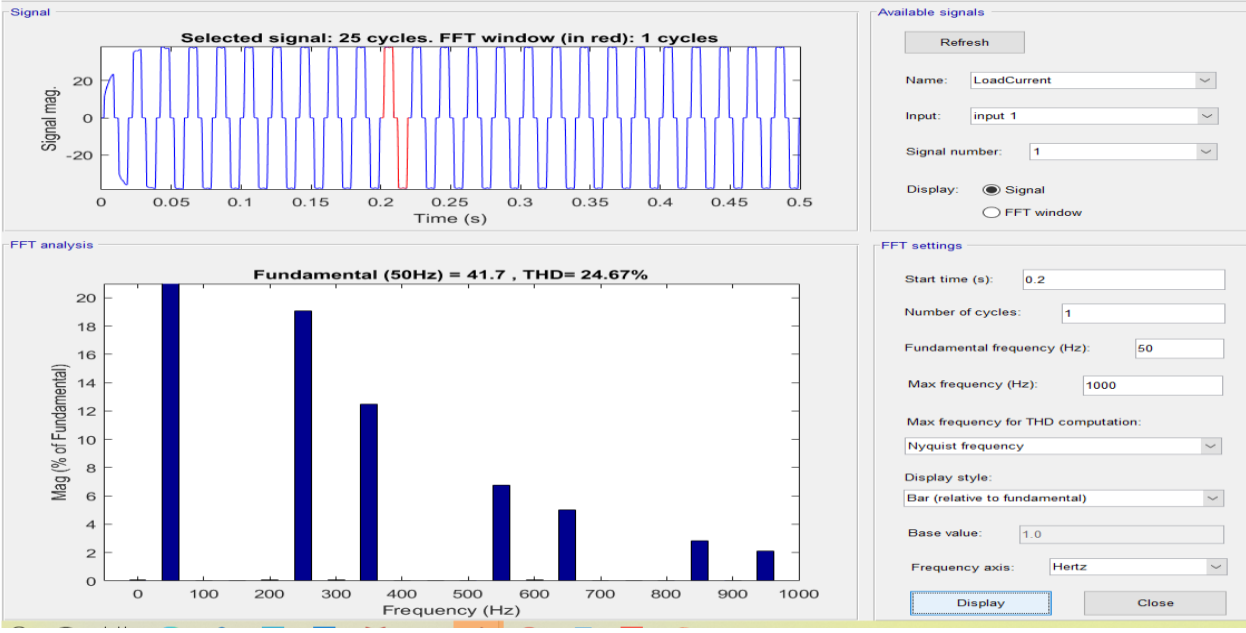
(E) supply current

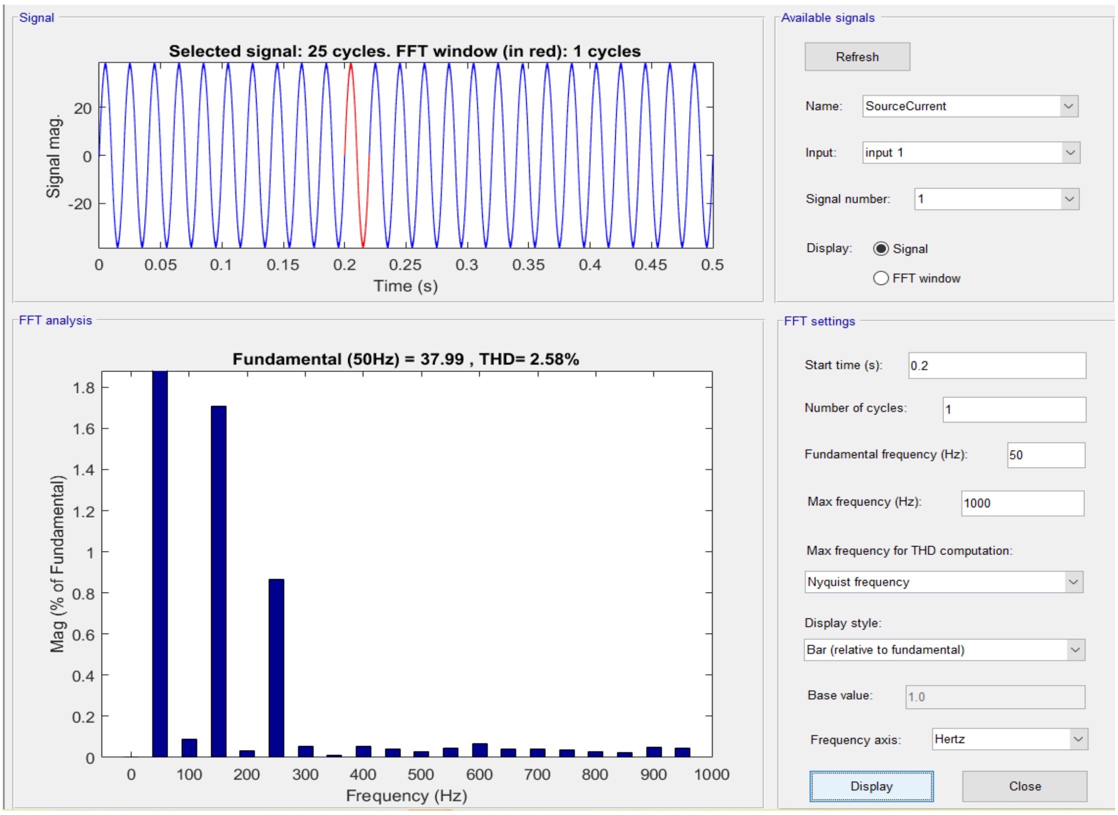


(F) Tracking Shunt Active Filter for Phase (a)



(G) Real Power Supplied by The Source to The Load.





7. Conclusion

Shunt active power filter is the most effective solution to mitigate the current harmonics and compensate the reactive power. In this paper a novel current control strategy based on fuzzy logic for shunt APF was introduced to improve the current controller technique that is the back bone of the shunt active power filter operation. The simulation results have verified the effectiveness of this new technique to fix the modulation frequency of the shunt active power filter compared to the conventional current controller where the modulation frequency changing over a wide range causing many of undesirable effects

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 1, 2022, p. 981 - 989
https://publishoa.com
ISSN: 1309-3452

References

[1]. S. Pal, P. S. Bond Riya, and Y. Pahariya, "MATLAB-Simulink Model Based Shunt Active Power Filter Using Fuzzy Logic Controller to Minimize the Harmonics," Int. J. Sci. Res. Publ., vol. 3, no. 12, pp. 7–11, 2013.

[2]. D. Prathyusha and P. Venkatesh, "UVTG Control Strategy for Three Phase Four Wire UPQC to Improve Power Quality," Int. Electr. Eng. J., vol. 6, no. 9, pp. 1988–1993, 2015.

[3]. S. F. Mekhamer and S. M. Ismael, "Sources and Mitigation of Harmonics in Industrial Electrical Power Systems : State of the Art," Online J. Power Energy Eng., vol. 3, no. 4, pp. 320–332, 2012.

[4]. W. M. Grady and S. Santoso, "Understanding power system harmonics," IEEE Power Eng. Rev., vol. 21, pp. 8–11, 2001.

[5]. A. N. Jog and N. G. Apte, "An adaptive hysteresis band current controlled shunt active power filter," 5th Int. Conf. Compat. Power Electron. CPE 2007, pp. 8031–8040, 2007.

[6]. Z. Salam, P. C. Tan, and A. Jusoh, "Harmonics mitigation using active power filter: a technological review," Electrical, vol. 8, no. 2, pp. 17–26, 2006.

[7]. A. Teke, L. Saribulut, M. E. Meral, and M. Tümay, "Active Power Filter : Review of Converter Topologies and Control Strategies," Gazi Univ. J. Sci., vol. 24, no. 2, pp. 283–289, 2011.

[8]. B. Singh, K. Al-Haddad, S. Member, and A. Chandra, "A Review of Active Filters for Power Quality Improvement," IEEE Trans. Ind. Electron., vol. 46, no. 5, pp. 960–971, 1999.

[9]. A. Martins, J. Ferreira, and H. Azevedo, "Active Power Filters for Harmonic Elimination and Power Quality Improvement," in Power Quality, 2011, pp. 162–182.

[10]. C. Veeresh, "Shunt Active Filter for Power Quality Improvement," Int. J. Eng. Res. Gen. Sci., vol. 3, no. 4, pp. 136–148, 2015.

[11]. E. Mhawi, H. Daniyal, and M. H. Sulaiman, "Advanced Techniques in Harmonic Suppression via Active Power Filter: A Review," Int. J. Power Electron. Drive Syst., vol. 6, no. 2, 2015.

[12]. J. L. Afonso, J. G. Pinto, and H. Gonçalves, "Active Power Conditioners to Mitigate Power

[13]. Quality Problems in Industrial Facilities," in Power Quality Issues, 2013, pp. 105–138.

[14]. S. Chourasia and S. Agarwal, "A REVIEW: Control Techniques for Shunt Active Power Filter for Power Quality Improvement from Non-Linear Loads," Int. Electr. Eng. J., vol. 6, no. 10, pp. 2028–2032, 2015.

[15]. P. A. Prasad, N. V. V Ramesh, and L. V Narasimha Rao, "Modified Three-Phase Four-Wire UPQC Topology with Reduced DC-Link Voltage Rating," Int. Electr. Eng. J., vol. 6, no. 2, pp. 1749–1755, 2015.

[16]. F. Z. Peng, "Application issues of active power filters," Ind. Appl. Mag. IEEE, vol. 4, no. 5, pp. 21–30, 1998.

[17]. G. Adam, A. G. S. Baciu, and G. Livinţ, "a matlab-simulink approach to shunt active power filters," in 25th European Conference on Modelling and Simulation, 2011, vol. 6, no. Cd, pp. 2–7.

[18]. M. Kale and E. Özdemir, "Harmonic and reactive power compensation with shunt active power filter under non-ideal mains voltage," Electr. Power Syst. Res., vol. 74, no. 3, pp. 363– 370, Jun. 2005.

[19]. A. G. Prasad and A. N. Kumar, "Comparison of Control Algorithms for Shunt Active Filter for Harmonic Mitigation," Int. J. Eng. Res. Technol., vol. 1, no. 5, pp. 1–6, 2012.