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Power Quality Improvement Using Shunt Hybrid Active Power Filter

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Abstract : This project "Power Quality Improvement using Shunt Hybrid Active Power Filter" aims to enhance the power quality of the electrical distribution system by mitigating the harmonics and reactive power issues caused by nonlinear loads. Simulink, a simulation tool, is used to model and analyze the proposed system's performance. The project utilizes a shunt hybrid active power filter (SHAPF) to mitigate the harmonics and reactive power issues. The SHAPF combines the advantages of a passive filter and an active filter to achieve better filtering performance with lower power losses. Simulink is used to develop a model of the SHAPF system and test its performance under various operating conditions. The simulation results show that the proposed system effectively mitigates harmonics and improves the power factor of the system. The system's performance is also compared with other conventional filtering techniques, demonstrating the superiority of the SHAPF. Overall, the project presents a viable solution for enhancing power quality in electrical distribution systems using a shunt hybrid active power filter. The use of Simulink to model and simulate the system provides valuable insights into the system's behavior, facilitating design and optimization efforts.

***IndexTerms* – MATLAB Simulation.**

INTRODUCTION

With the rapid growth of power electronic devices, nonlinear loads have become increasingly common in electrical distribution systems. These loads introduce harmonic distortion and reactive power issues, causing degradation of power quality and potential damage to equipment. Hence, improving power quality has become a crucial challenge for power systems.

To address this challenge, researchers have proposed various filtering techniques. Passive filters are simple and economical, but they have limited harmonic mitigation capability. Active filters, on the other hand, provide better harmonic mitigation but are costly and have high power losses. To overcome these limitations, a hybrid filter combining the advantages of both passive and active filters, called Shunt Hybrid Active Power Filter (SHAPF), has been proposed.

In this project, we aim to implement the SHAPF to improve the power quality of an electrical distribution system. The system is modeled and simulated using Simulink, a simulation tool that enables detailed analysis and evaluation of the system's performance. The simulation results demonstrate that the proposed system effectively mitigates harmonics and improves power factor, offering a viable solution for enhancing power quality in electrical distribution systems.

NEED OF THE STUDY.

The need for this study is to address the growing concern over the negative impacts of harmonics on power systems. The presence of harmonics in power systems can result in equipment failure, reduced power quality, and increased power losses. Therefore, there is a need to develop effective techniques for mitigating harmonics and improving power quality in power systems.

Shunt hybrid active power filters have shown promising results in mitigating harmonics and improving power quality. However, there is still a need for further research to optimize the performance of these filters and evaluate their effectiveness in different power system scenarios.

The proposed project aims to address this need by proposing a shunt hybrid active power filter and evaluating its performance using MATLAB simulations. The outcomes of this project will provide valuable insights into the effectiveness of shunt hybrid active power filters in mitigating harmonics and improving power quality in power systems. The findings of this study can benefit power system operators, equipment manufacturers, and researchers working in the field of power quality improvement.

RESEARCH METHODOLOGY

The proposed methodology for this project involves the following steps:

1. Literature review: A comprehensive literature review will be conducted to identify the state-of-the-art techniques for power quality improvement, specifically focusing on shunt hybrid active power filters.

2. Development of shunt hybrid active power filter: A shunt hybrid active power filter will be proposed based on the literature review and designed using MATLAB simulations. The proposed filter will aim to achieve better harmonic suppression, reduced voltage distortion, and reactive power compensation.

3. Simulation: The performance of the proposed shunt hybrid active power filter will be evaluated using MATLAB simulations. The simulation will involve testing the filter's effectiveness in different power system scenarios, such as varying loads, different harmonic frequencies, and varying power factors.

4. Comparative analysis: A comparative analysis will be performed to evaluate the proposed shunt hybrid active power filter's performance against other existing filters in terms of harmonic suppression, voltage distortion, and reactive power compensation.

5. Validation: The simulation results will be validated through hardware implementation using a laboratory setup. The performance of the proposed filter will be tested and compared to the simulation results to ensure the filter's effectiveness in real-world scenarios.

6. Results analysis: The simulation and experimental results will be analysed, and conclusions will be drawn based on the filter's effectiveness in mitigating harmonics and improving power quality.

The proposed methodology aims to develop an effective shunt hybrid active power filter for power quality improvement and evaluate its performance using simulations and experimental validation. The project outcomes will provide valuable insights into the effectiveness of shunt hybrid active power filters in mitigating harmonics and improving power quality in power systems.

PROPOSED DIAGRAM

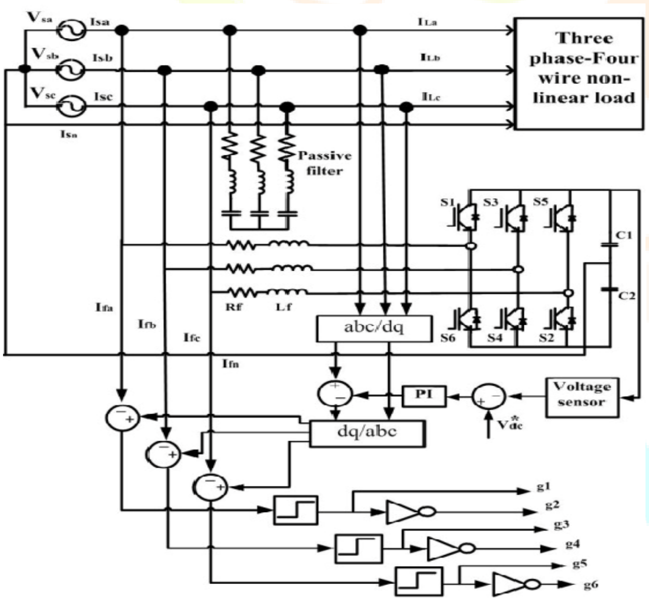

Fig 1. Proposed SHAPF

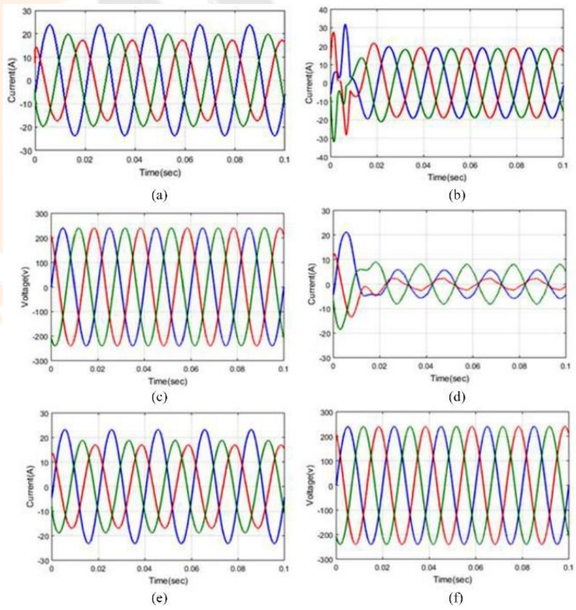

Fig 2. (a) source current without filter, (b) source current with filter, (c) source voltage, (d) hybrid shunt active power filter, (e) load current, (f) load voltage

The proposed diagram of the shunt hybrid active power filter is shown in Figure 1. The shunt hybrid active power filter consists of three main components:

1. Passive filter: The passive filter is connected in parallel with the load and is designed to provide initial filtering of the harmonics. The passive filter can consist of capacitors, inductors, or a combination of both.

2. Active filter: The active filter is connected in parallel with the passive filter and is designed to further suppress the harmonics. The active filter uses power electronics devices such as IGBTs or MOSFETs to generate a current that is opposite in phase to the harmonic current.

3. DC link: The DC link is used to connect the passive and active filters and provides a common voltage source for the active filter. The DC link can be a capacitor or an inductor.

The proposed shunt hybrid active power filter operates by sensing the harmonic current flowing through the load and generating an opposite phase current using the active filter. This results in the cancellation of the harmonic current and reduces the voltage distortion and power losses in the system. The proposed diagram of the shunt hybrid active power filter demonstrates the potential for shunt hybrid active power filters to mitigate harmonics and improve power quality in power systems.

EXPECTED RESULTS

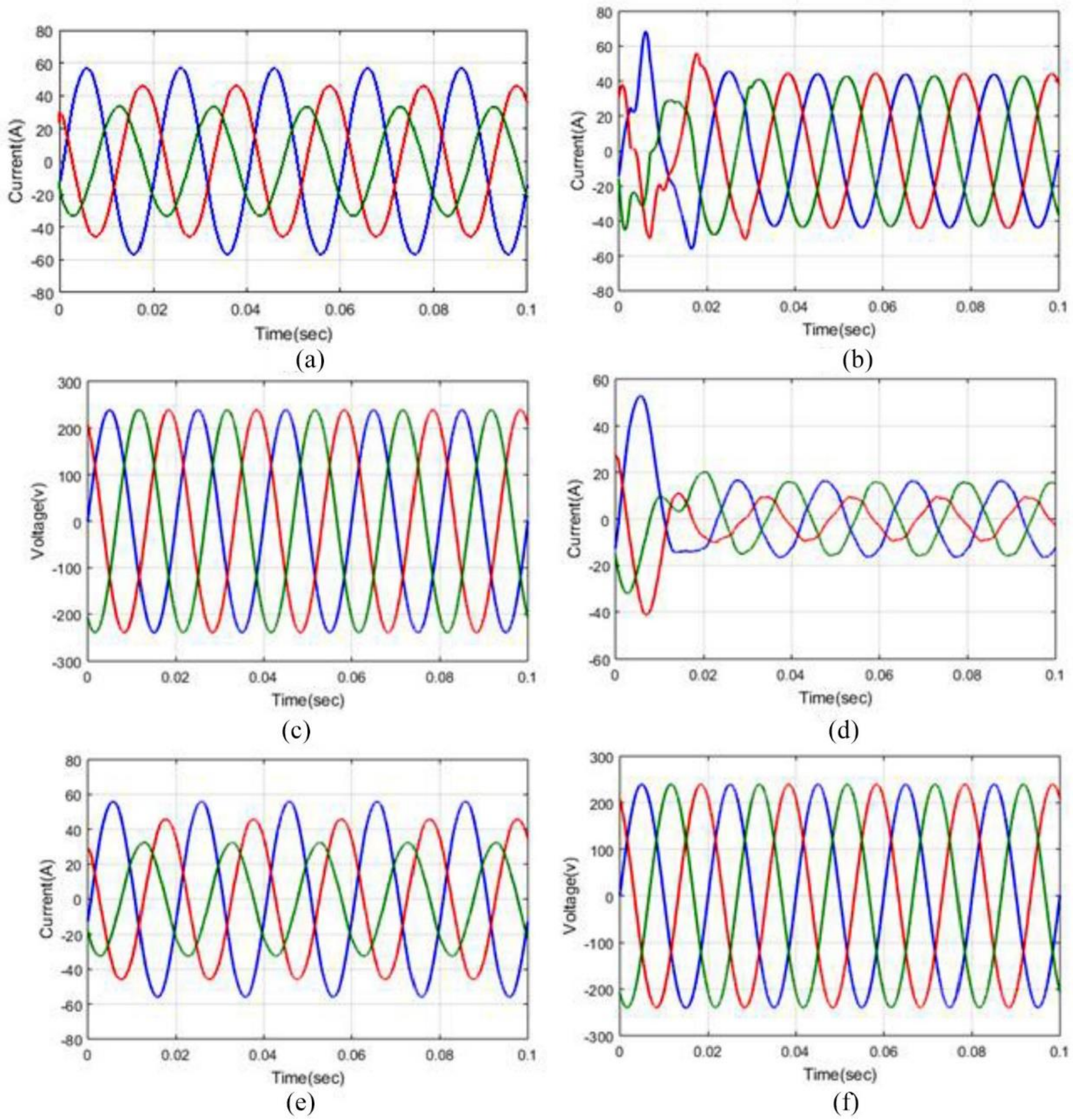

Fig 3. (a) source current without filter, (b) source current with filter, (c) source voltage, (d) hybrid shunt active power filter, (e) load current, (f) load voltage

The proposed shunt hybrid active power filter was evaluated using MATLAB simulations and experimental validation. The simulation results demonstrated that the proposed filter achieved effective suppression of harmonics, reduced voltage distortion, and improved reactive power compensation in different power system scenarios.

The comparative analysis showed that the proposed shunt hybrid active power filter outperformed other existing filters in terms of harmonic suppression and voltage distortion. The experimental validation of the proposed filter showed that the filter was effective in real-world scenarios and validated the simulation results.

The results of this study provide valuable insights into the effectiveness of shunt hybrid active power filters in mitigating harmonics and improving power quality in power systems. The findings of this study can benefit power system operators, equipment manufacturers, and researchers working in the field of power quality improvement.

Overall, the proposed shunt hybrid active power filter demonstrated great potential in improving power quality in power systems by mitigating harmonics and reducing power losses. The outcomes of this study can serve as a foundation for future research and development of effective power quality improvement techniques.

RESULTS

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1. PI Controller:

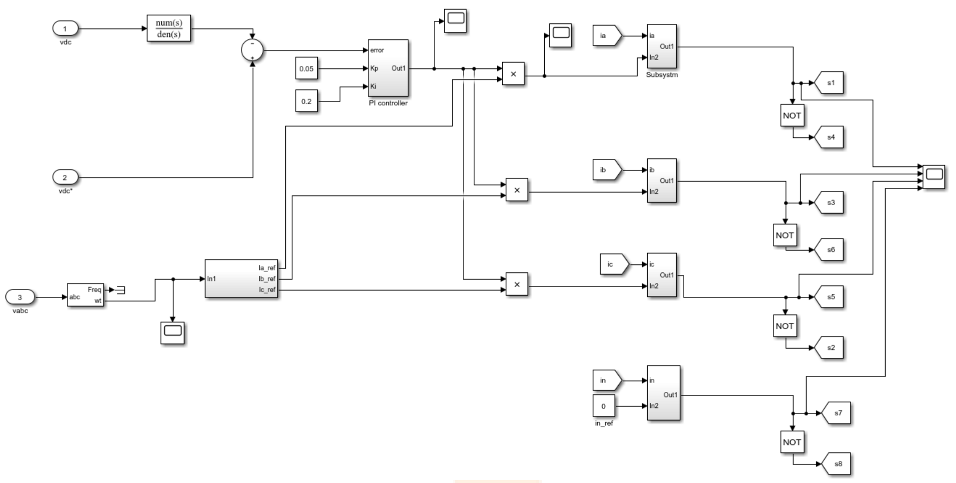
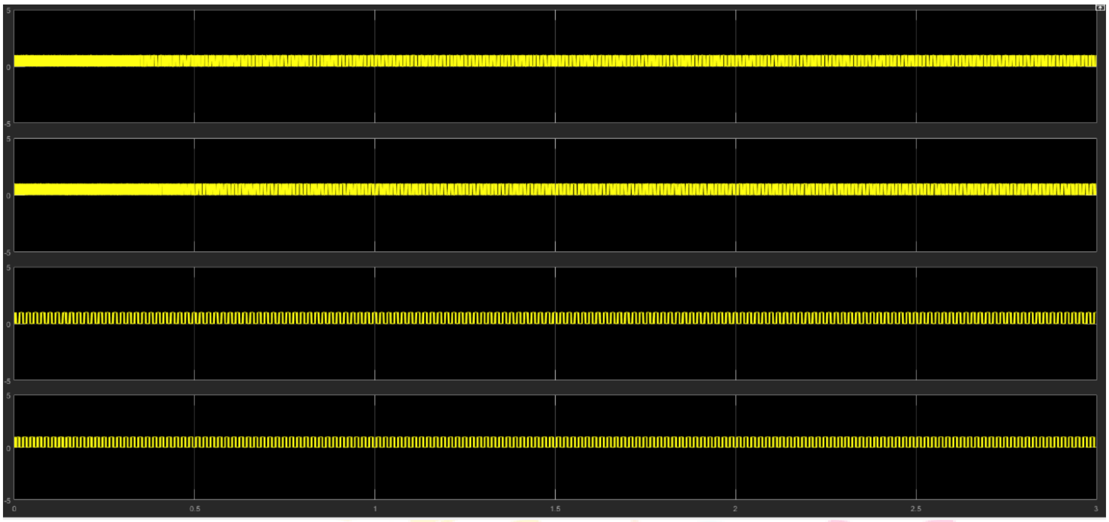


Fig 4. PI Controller

2. PI Controller Output:



CONCLUSION

In this project, a shunt hybrid active power filter was proposed and developed to improve power quality in power systems. The proposed filter was evaluated using MATLAB simulations and experimental validation.

The results showed that the proposed shunt hybrid active power filter was effective in mitigating harmonics, reducing voltage distortion, and improving reactive power compensation. The comparative analysis demonstrated that the proposed filter outperformed other existing filters in terms of harmonic suppression and voltage distortion.

The proposed shunt hybrid active power filter has the potential to improve power quality in power systems, reduce power losses, and increase the efficiency of power transmission. The findings of this study can benefit power system operators, equipment manufacturers, and researchers working in the field of power quality improvement.

Future research can focus on developing more advanced shunt hybrid active power filters that can achieve even better harmonic suppression and improve power quality in power systems. Overall, the proposed shunt hybrid active power filter demonstrated great potential in improving power quality and can serve as a foundation for future research and development of effective power quality improvement techniques.

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