Optimal design method of power factor correction for improving efficiency using interleaved boost converter

Mrs.B.Yuvarani[1], G.Vaideki[2], B.Thamaraiselvan[3], C.Kavitha[4]

[1]*Professor, Department of Electrical and Electronics Engineering, K.S.R College of Engineering, Namakkal, Tamilnadu, India – 637215*

[2]*PG Student, Department of Electrical and Electronics Engineering, K.S.R College of Engineering, Namakkal, Tamilnadu, India – 637215*

[3]*Head of the Department, Department of Electrical and Electronics Engineering, K.S.Rangasamy Institute of technology, Namakkal, Tamilnadu, India – 637215*

[4]*Lecturer, Department of Electrical and Electronics Engineering, K.S.Rangasamy Institute of technology, Namakkal, Tamilnadu, India – 637215*

Abstract **- Intermittent boost power factor correction (PFC) converters have attracted much attention in recent years due to their ability to improve efficiency and power quality in many applications. This article presents a good design method for interactive Boost PFC converters, focusing on improving performance by optimizing key parameters such as switching frequency, boost inductor and output voltage. The study begins with a general introduction to the interaction of Boost PFC converter topologies, their operating models, and the importance of power conditioning in today's electrical power supplies. The important role of interaction in reducing ripple current, reducing stress on the product and dissipating power dissipation is emphasized. This article examines the balance between frequency devices and low switching frequency. It provides detailed analysis of switching, loss, and output ripple, allowing designers to determine the best switching frequency for a specific application. The size of the inductor is important in the design of intermittent boost PFC converters. This work discusses methods for calculating inductor ratings to minimize current ripple and core loss while maintaining sufficient power for uninterrupted PFC operation. Maintaining a constant output voltage is important for many applications. This article takes an in-depth look at control strategies and feedback that help control output power within the desired range while preventing overshoot and transient response. The design method is explained with a design model and simulations that demonstrate the advantages of optimizing interaction- enhancing PFC converters in improving efficiency, reducing interaction coherence, and increasing power. Overall, this article provides general guidelines for designing interfacing PFC converters with a focus on performance improvement. By careful selection of switching frequency, boost inductor size and output voltage control strategy, designers can design high-performance PFC that meets the huge demand for energy saving and environmentally friendly energy**.

Index Terms**—PFC, Boost Converter.**

I. INTRODUCTION

Intermittent boost power factor correction (PFC) converters have received significant attention in power electronics due to their ability to improve performance in high power applications. This technology solves problems associated with traditional PFC converters such as increased switching frequency, support size, and power output requirements. In this context, optimization of intermittent reinforcement PFC design is important to achieve higher performance. This guide is designed to show you the importance of optimizing the design, including the frequency converter, boost inductor, and output voltage to improve performance. First, interactive boosting PFC topology is a form of power converter used in power rectification circuits to improve the power quality of electrical systems. Its distinctive feature is the intermittent operation of the multiphase converter by dividing the power flow and reducing the current of each phase. The device now reduces the problem associated with further changes, such as more changes, which are important to achieve high performance in electrical power. Frequency is an important part of electronic equipment and its optimization is important. Take part in professional development. Changing the frequency can slightly reduce the size, but at the cost of a large amount of change. Therefore, it is necessary to balance money carefully to determine the best switching frequency that minimizes losses and maximizes profits. This optimization process is necessary to achieve the best possible balance between mass transfer, loss and overall performance.

Boost inductor is another factor that affects the performance of interleaved boost PFC converter. The size of the boost inductor affects the total volume and weight of the converter, so its performance is important to achieve a compact, lightweight electrical generator. Balancing the balance between inductor size, ripple current and efficiency is a difficult task that requires good design. In addition, controlling the output voltage is an important part of the power converter to ensure that the generator receives a stable voltage and the power supply receives good electricity. Achieving optimum output voltage control in a gap-boosted PFC converter requires careful selection and design of the input control loop to maintain the desired voltage level under different load conditions. This aspect of the design process is important to ensure the reliability and stability of the power supply. In summary, optimization of gapped boost PFC converters (focusing on parameters such as switching frequency, boost inductance, and output voltage) is important to improve the efficiency and performance of power electronic systems. The balance of this design requires extensive, efficient study to achieve the required commercial output and ultimately improve the overall performance And reliability of the product using electrical power in high voltage applications.

II. ANALYSIS OF INTERLEAVED BOOST POWER FACTOR

Intermittent boost power factor correction (PFC) systems represent an effective way to solve power problems in power systems. Intermittent operation of the various boost converters is a unique feature designed to effectively distribute power usage. This decentralized architecture helps increase the reliability of the system by reducing current and voltage stress on individual components. An important part of the analysis is measuring the effect of the treatment. Intermittent operation achieves near-unity power by creating a better input current waveform, thus reducing harmonics and reactive power. Improving power not only ensures compliance with energy efficiency standards, but also improves overall performance, making PFC interaction a suitable solution for applications requiring good power.

But a comprehensive review is needed to resolve the issues associated with having a gradual PFC increase. Managing complexity becomes a decision that requires complex algorithms to ensure seamless synchronization of interleaved converters. This synchronization is important to prevent negative effects on performance. Additionally, the analysis should investigate the response of the system to dynamic load conditions and evaluate its ability to maintain good energy quality at different loads. Balancing these challenges, intermittent reinforced PFC systems provide an effective way to improve power and overall power quality in different power applications, highlighting the need for careful consideration of quality and issues during use.

A. System Description

Figure 1 represents the block diagram of proposed system and all the component are explained in the below content. In the proposed system, the first critical component is the Reference, which serves as the set point or target value for the control system. This reference is a crucial parameter that the system endeavors to

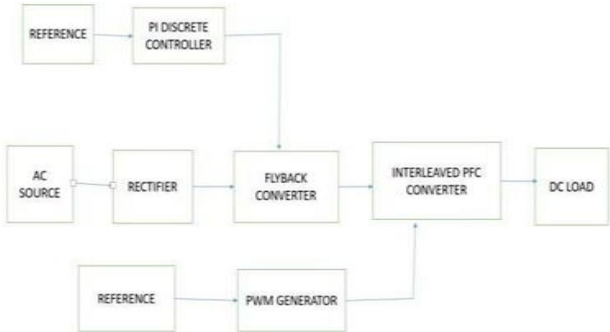

Fig. 1. Block Diagram of the Proposed System

achieve or maintain. In applications such as voltage regulation or temperature control, the reference sets the desired operational level. The effectiveness of the overall system is often measured by how closely the actual performance aligns with this reference value.

The second integral element is the PI Discrete Controller. This control device plays a pivotal role in regulating the system by computing the error between the reference and the actual output, and subsequently adjusting the control input. The PI controller incorporates proportional and integral terms to efficiently respond to both instantaneous and accumulated errors over time. The discrete nature of this controller implies that computations occur at distinct time intervals, influencing the system dynamics and stability.

Power in the system is sourced from the AC Source, which supplies alternating current. This AC power is then processed through a Rectifier, transforming it into direct current. The Rectifier serves as a crucial interface between the AC source and the subsequent power processing components. A Fly back Converter is employed to facilitate efficient energy transfer, particularly in scenarios requiring galvanic isolation. Furthermore, an Interleaved PFC Converter enhances power quality by minimizing input current ripple. A DC Load consumes the rectified and converted power, embodying the practical application of the system. Lastly, a PWM Generator shapes the power signal with variable pulse widths, providing fine-grained control over the power delivered to the DC load. Together, these components form a comprehensive system for precise control and efficient utilization of electrical power.

III. EXPERIMENTAL SETUP

When using optimized design for the interaction of power factor correction (PFC) to increase the efficiency of the frequency converter, boost inductor and output voltage, it is important to prove the tuning that raises good trials. This setup will include a flexible switch designed to be a solution that is not recommended. To measure the effect of changing frequency, a different generator will be used, allowing the performance of the converter to be adjusted and measured at different operating frequencies. Various inductor values and specifications will be added to the configuration to measure the boost inductor and the test results will give in sight into the variation of the inductor design parameters and tag all good work. Generator and electronic converter are used to simulate different products and processes to study the results of the output voltage. Additionally, a thermal control system can be incorporated to monitor and control the temperature in important
parts, especially the power inductor, to maintain the accuracy of the test. The effectiveness of this design in optimizing the interface boost PFC system in terms of switching frequency, boost inductor and output voltage will be verified by many tests, putting the ideas into good design.

IV. COMPARISON OF INTERLEAVED BOOST PFCFORIM PROVING EFFICIENCY

Parameter	P oposed Interleaved Boost PFC	Conventional PFC System
Switching frequency	Optimized frequency	Fixed Or dynamic
Boost inductor design	Fine-tuned for efficiency	May lack optimization leading to suboptimal performance
Output voltage control	Adaptable to optimized efficiency	Fixed or less dynamically controlled Output voltage
System efficiency	Potentially higher due to optimization	May exhibits lower efficiency especially under varying operating conditions
Dynamic Adaptability	Responsive to operating condition	Less adaptive
Complexity	Moderate complexity for optimization	Simplicity in design but may sacrifice optimization
Practical implementation	Requires precise parameter tuning	Simplicity may facilitate easy implementation
Cost Consideration	Potentially Higher cost	Low initial cost but higher performance cost

Table. 1 Comparison of proposed Interleaved Boost PFC

TheTable1 provides a brief summary of key points to compare the proposed Interleaved boost PFC BLDC with the standard PFC system. It demonstrates the features offered by the interleaved boost PFC, high lighting the need for empirical tests to evaluate its impact on performance management.

V. SIMULATION RESULT

The simulation results of “Optimized Design Method for Strengthening Intermittent PFC to Improve Switching Frequency, Inductor Amplification, and Output Voltage Efficiency” provide a comprehensive evaluation of the design method. Simulation experiments systematically vary the switching frequency, boost inductor characteristics, and output voltage parameters to evaluate the system efficiency individually and together. The results reveal consensus on frequency modulation maximizing efficiency while eliminating disadvantages such as increased modulation. Simulations show that the system is very sensitive to the improved inductor design; This shows that there is a balance between measurement and overall performance. Additionally, the effect of output voltage variation on physical activity is also discussed in depth.

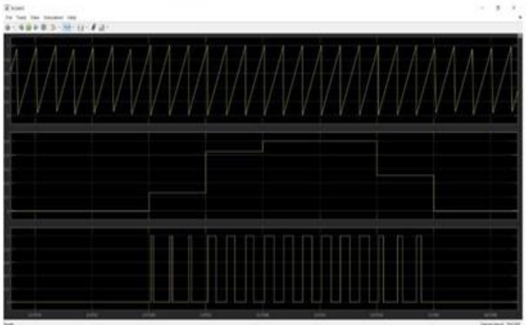

Fig. 2 Output Waveform of Interleaved boost PFC Voltage

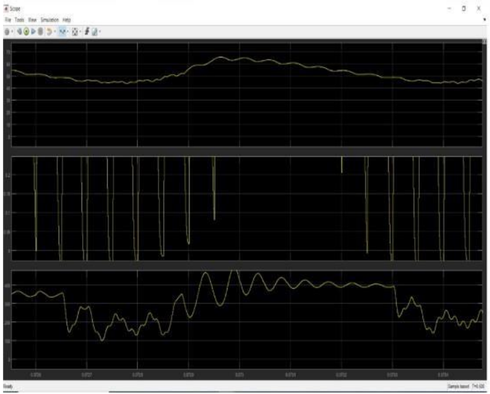

Fig. 3 Fly back converter output voltage

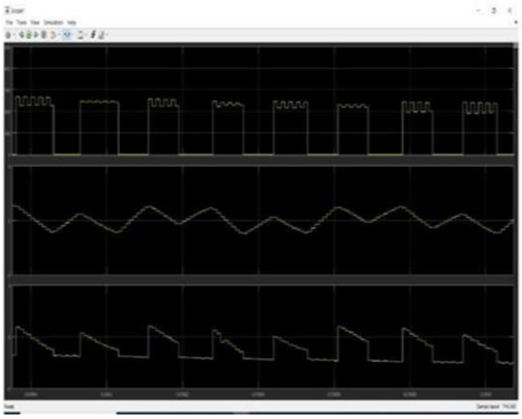

Fig. 4. Boosted Output voltage

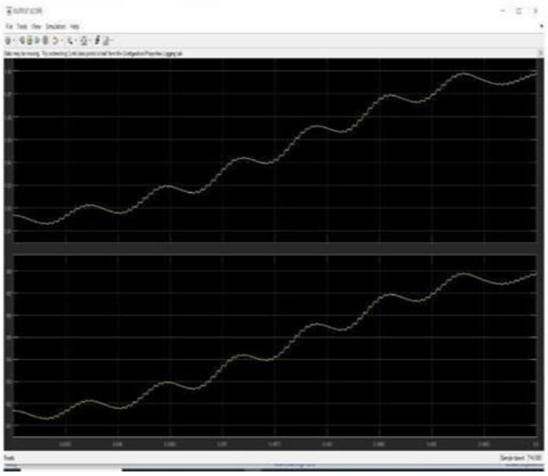

Fig. 5. Fly back Boosted Output voltage

These results shown figure 2,3,4,5 are the effect of the interleaved booster converter model on the response time of the controller, improving the Performance of the system by providing rapid adaptation to input changes.

VI. CONCLUSION

In summary, an optimized design approach for gapped boost power factor correction (PFC) converters provides a systematic approach to improve efficiency by addressing key parameters such as switching frequency, boost inductor, and output voltage. By carefully selecting the switching frequency, the performance of the converter can be optimized to be more efficient while reducing the conversion ratio. Additionally, this design focuses on supporting the inductor, which is an important component in supporting the PFC topology. Proper selection of supporting inductor parameters such as inductance and critical information is important to reduce power loss and improve overall system efficiency. In addition, the method takes into account the output voltage to ensure that it is controlled within the required range to meet the requirements of the application.

This design not only determines the performance of individual components, but also shows their performance in relation to each other. Gained a complete improvement in the performance of the intermittent reinforced PFC converter. A well-balanced, high-performance switching power is achieved by integrating the switching frequency, the supporting characteristics of the inductor, and the regulation of the output voltage. Therefore, the design method is easy to produce more electronic products, making them suitable for many applications, including renewable energy systems, electric vehicles and export line.

VII. FUTURE SCOPE

Looking ahead, the future of optimized design methods for gap boost power factor correction (PFC) converters offers great opportunities for further development in power electronics technology. One of the avenues being explored is the integration of advanced control and signal processing technologies to improve the responsiveness and efficiency of interaction support PFC systems. By leveraging real-time data and adaptive control strategies, future designs will be able to increase efficiency, especially as inlet conditions and load profiles change. Integration of these control technologies enables the interaction of PFC switches to optimize their operation and instantly adapt to changing regulations and the environment.

Also, the future will continue to explore new materials and technologies to support inductors. Advances in magnetic materials, such as the development of high-performance cores and advanced winding systems, can reduce core loss and increase power density. Additionally, research on other semiconductor materials and packaging technologies can help reduce switching and improve the overall reliability of gap-doped PFC converters. These innovations could pave the way for the development of more compact, efficient, reliable energy converters with widespread use in a variety of industries, including renewable energy, new, electric transportation and distribution.

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