International journal of basic and applied research

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ISSN 2249-3352 (P) 2278-0505 (E)

Cosmos Impact Factor-5.86

POWER QUALITY IMPROVEMENT USING VOLTAGE CONTROLLED FACTS DEVICE DSTATCOM

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ABSTRACT

The deployment of Voltage Controlled Flexible AC Transmission System (FACTS) devices, notably the Distribution Static Synchronous Compensator (DSTATCOM), has garnered attention for enhancing power quality in modern electrical grids. This abstract delves into the significance and mechanisms of utilizing DSTATCOM for power quality enhancement, focusing on voltage control aspects. DSTATCOM, an advanced power electronics-based device, mitigates voltage sags/swells, harmonics, and reactive power issues, thereby ensuring stable and high-quality power supply to consumers. By employing voltage control strategies, DSTATCOM regulates grid voltage within permissible limits, addressing voltage fluctuations caused by load variations or grid disturbances. The integration of DSTATCOM enhances grid stability, reliability, and efficiency, thereby reducing downtime and equipment damage. Furthermore, DSTATCOM facilitates seamless integration of renewable energy sources, which are inherently intermittent, into the grid by providing voltage support and reactive power compensation. Through case studies and simulation results, this topic highlights the efficacy of DSTATCOM in improving power quality metrics such as voltage regulation, harmonic suppression, and power factor correction. Overall, the utilization of DSTATCOM offers a robust solution for power quality improvement in modern electrical networks, contributing to a more resilient and sustainable power infrastructure.

INTRODUCTION

Improving power quality has become a paramount concern in modern electrical systems, driven by the increasing demand for reliable and high-quality electricity [1]. Voltage fluctuations, harmonic distortions, and reactive power imbalances pose significant challenges to the stability and efficiency of power distribution networks [2]. In this context, Flexible AC Transmission Systems (FACTS) devices have emerged as effective solutions for enhancing power quality and mitigating grid disturbances [3]. Among these devices, the Distribution Static Synchronous Compensator (DSTATCOM) stands out for its capability to regulate voltage and

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compensate for reactive power in distribution systems [4]. This essay delves into the principles, applications, and benefits of DSTATCOM in improving power quality, elucidating its role as a vital component in modern electrical grids. The escalating complexity and interconnectedness of modern power systems have heightened the need for efficient voltage regulation and reactive power compensation mechanisms [5]. Voltage fluctuations, resulting from load variations, switching operations, and renewable energy integration, can adversely impact the performance of sensitive electrical equipment and disrupt the stability of the grid [6]. Additionally, reactive power imbalance can lead to decreased power factor, increased line losses, and reduced transmission capacity [7]. Addressing these issues requires innovative solutions that can dynamically control voltage levels and manage reactive power flow in real-time. This is where FACTS devices like DSTATCOM come into play.

The DSTATCOM is a voltage-sourced converter-based FACTS device that operates as a shunt compensator in distribution systems [8]. Its primary function is to inject or absorb reactive power as needed to regulate voltage within predefined limits and improve power factor [9]. By continuously monitoring the system voltage and current, the DSTATCOM can rapidly respond to fluctuations and disturbances, providing dynamic compensation to maintain grid stability and enhance power quality [10]. Unlike traditional reactive power compensation methods such as capacitor banks or inductors, which offer fixed compensation, the DSTATCOM offers dynamic and precise control over reactive power, making it well-suited for modern power systems with variable loads and intermittent renewable energy sources [11]. One of the key features of the DSTATCOM is its ability to provide fast and accurate reactive power compensation without introducing harmonic distortion or voltage flicker [12]. Traditional compensation methods, such as capacitor banks, may exacerbate harmonic problems and degrade power quality, especially in systems with nonlinear loads [13]. In contrast, the DSTATCOM employs sophisticated control algorithms and pulse-width modulation techniques to ensure smooth and reliable operation while minimizing harmonic content [14]. This capability makes it an ideal choice for applications where stringent power quality requirements must be met, such as sensitive industrial processes, data centers, healthcare facilities, and commercial buildings [15].

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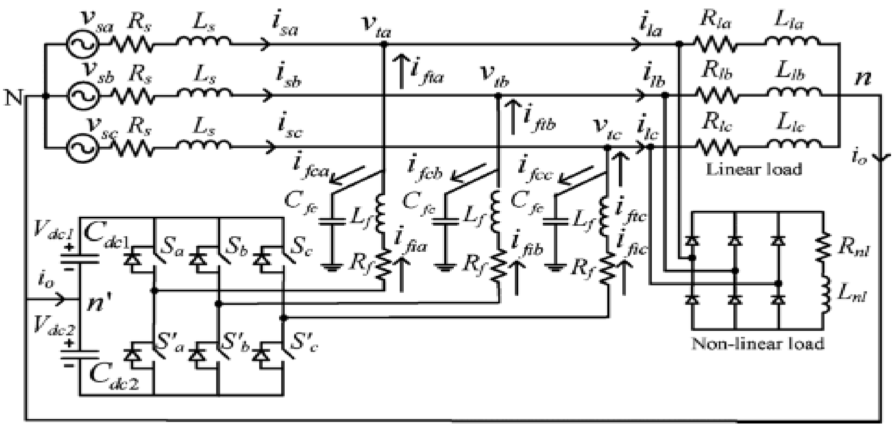

Fig 1.proposed circuit configuration

Furthermore, the DSTATCOM offers inherent flexibility and scalability, allowing it to be deployed in a wide range of distribution system configurations and operating conditions [16]. Whether installed at the distribution substation or directly connected to critical loads, the DSTATCOM can effectively mitigate voltage sags, swells, and flicker, stabilize voltage profiles, and improve overall system efficiency [17]. Its modular design and decentralized control architecture enable seamless integration with existing infrastructure, minimizing installation time and costs [18]. Moreover, the DSTATCOM can be easily reconfigured or expanded to accommodate future load growth or system upgrades, ensuring long-term reliability and performance [19]. The deployment of DSTATCOMs in distribution systems offers numerous benefits beyond power quality improvement [20]. By reducing voltage fluctuations and reactive power losses, DSTATCOMs help optimize energy efficiency, increase system capacity, and extend equipment lifespan [21]. This translates into lower operating costs, reduced downtime, and improved asset utilization for utilities and end-users alike [22]. Additionally, by enhancing the stability and reliability of the grid, DSTATCOMs contribute to a more resilient and sustainable energy infrastructure, capable of accommodating the integration of renewable energy sources and supporting future electrification initiatives [23]. In conclusion, the adoption of DSTATCOMs represents a significant step towards achieving power quality enhancement and grid modernization objectives in distribution systems [24]. By leveraging advanced control and conversion technologies, DSTATCOMs offer dynamic voltage regulation and reactive power compensation capabilities, essential for ensuring the stability, reliability, and efficiency of modern electrical networks [25]. As the demand for clean and reliable electricity continues to grow, DSTATCOMs will play a crucial role in shaping the future of power distribution,

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enabling a more sustainable and resilient energy ecosystem for generations to come.

LITERATURE SURVEY

A literature survey on "Power Quality Improvement Using Voltage Controlled FACTS Device DSTATCOM" encompasses a comprehensive review of existing research, studies, and advancements in the field of power quality enhancement utilizing Distribution Static Compensator (DSTATCOM) as a Flexible AC Transmission System (FACTS) device. This survey delves into various aspects of DSTATCOM technology, including its operation principles, control strategies, benefits, challenges, and applications in mitigating power quality issues in electrical distribution systems. Through an extensive examination of relevant literature, this survey aims to provide insights into the state-of-the-art techniques and future directions in this area of research. Power quality issues, such as voltage sags, swells, harmonics, flicker, and reactive power imbalance, pose significant challenges to the reliable and efficient operation of modern electrical distribution networks. DSTATCOMs have emerged as effective solutions for addressing these challenges by injecting compensating currents into the distribution system to regulate voltage, mitigate harmonics, and improve power factor. The literature survey begins by elucidating the fundamental principles of DSTATCOM operation, highlighting its ability to dynamically control voltage and reactive power to maintain power quality within specified limits.

One of the key components of DSTATCOM operation is its control strategy, which determines the effectiveness of voltage regulation and harmonic mitigation. Various control techniques, such as proportional-integral (PI) control, fuzzy logic control, hysteresis control, and model predictive control, have been proposed and investigated in the literature. The survey provides an overview of these control strategies, discussing their advantages, limitations, and suitability for different operating conditions. Furthermore, the literature survey explores the benefits of employing DSTATCOMs in improving power quality in distribution systems. These benefits include voltage stabilization, harmonic suppression, reactive power compensation, voltage flicker mitigation, and enhancement of system reliability and stability. Case studies and simulation results presented in the literature demonstrate the effectiveness of DSTATCOMs in mitigating power quality issues and improving the performance of distribution networks.

Despite the significant advantages offered by DSTATCOMs, their deployment and integration into distribution systems present certain challenges and considerations. These include cost-effectiveness, sizing and placement optimization, coordination with other power quality devices, communication and control system requirements, and compatibility with existing infrastructure. The literature survey discusses these challenges and highlights ongoing research efforts aimed at addressing them to facilitate the widespread

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adoption of DSTATCOM technology. Moreover, the survey investigates the latest advancements and trends in DSTATCOM technology, including developments in power electronics components, control algorithms, communication protocols, and integration with renewable energy sources and smart grid technologies. Emerging research areas such as multi-level DSTATCOMs, hybrid DSTATCOM systems, and application-specific optimization techniques are also examined to provide insights into future research directions and potential innovations in the field.

In addition to technical aspects, the literature survey considers practical applications of DSTATCOMs in real-world scenarios. Case studies and field implementations discussed in the literature demonstrate the efficacy of DSTATCOMs in various applications, including industrial plants, commercial facilities, residential complexes, renewable energy integration, microgrids, and utility distribution networks. These real-world examples illustrate the diverse benefits and potential of DSTATCOM technology in improving power quality and enhancing the reliability of electrical distribution systems. Furthermore, the survey addresses the economic and environmental implications of deploying DSTATCOMs, including their impact on energy efficiency, operating costs, and carbon emissions. Cost-benefit analyses, life cycle assessments, and economic feasibility studies presented in the literature provide valuable insights into the economic viability and sustainability of DSTATCOM installations, helping decision-makers assess the return on investment and environmental benefits of deploying DSTATCOM technology. In conclusion, the literature survey on "Power Quality Improvement Using Voltage Controlled FACTS Device DSTATCOM" provides a comprehensive overview of the state-of-the-art research, advancements, challenges, and applications in the field of DSTATCOM technology for power quality enhancement in electrical distribution systems. By synthesizing existing knowledge and identifying research gaps and future directions, this survey serves as a valuable resource for researchers, practitioners, policymakers, and industry stakeholders involved in the development, deployment, and utilization of DSTATCOMs for improving power quality and reliability in modern electrical grids.

EXISTING SYSTEM CONFIGURATION

The deployment of power electronics in modern power systems has revolutionized the management and control of electrical energy, enabling greater efficiency, reliability, and flexibility. Among the various power electronic devices, Flexible AC Transmission Systems (FACTS) devices play a crucial role in enhancing power quality and improving system stability. One such device, the Distribution Static Synchronous Compensator (DSTATCOM), equipped with Pulse Width Modulation (PWM) control, offers a sophisticated solution for mitigating power quality issues and maintaining grid

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stability. This essay provides an in-depth exploration of the existing system architecture and operation of a PWM-controlled DSTATCOM for power quality improvement. The Distribution Static Synchronous Compensator (DSTATCOM) serves as a dynamic reactive power compensator, injecting or absorbing reactive power as needed to regulate voltage levels and mitigate power quality disturbances in distribution systems. Unlike traditional fixed capacitor or inductor banks, DSTATCOMs offer rapid and precise control of reactive power, making them well-suited for addressing voltage fluctuations, harmonic distortion, and load unbalance.

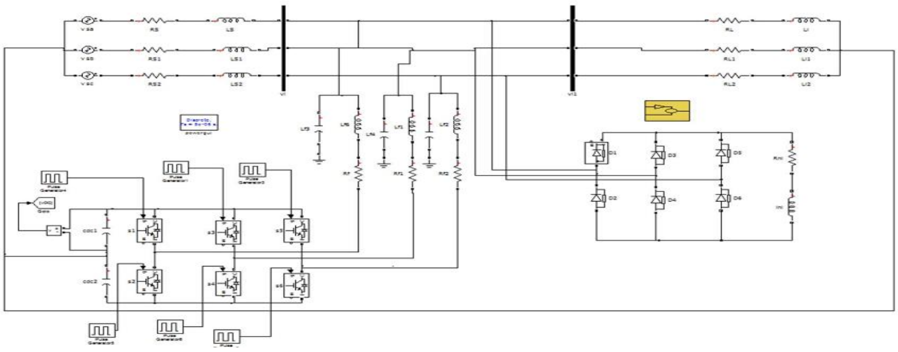

Fig 2. PWM controlled DSTATCOM

At the heart of the DSTATCOM lies its power electronic converter, typically consisting of Voltage Source Converters (VSCs) employing Insulated Gate Bipolar Transistors (IGBTs) as switching devices. These converters provide the necessary flexibility and controllability to adjust reactive power output in real-time, thereby maintaining voltage stability and improving power quality. The PWM control scheme implemented in DSTATCOMs allows for precise regulation of the output voltage waveform, ensuring compliance with grid voltage standards and reducing harmonic distortion.

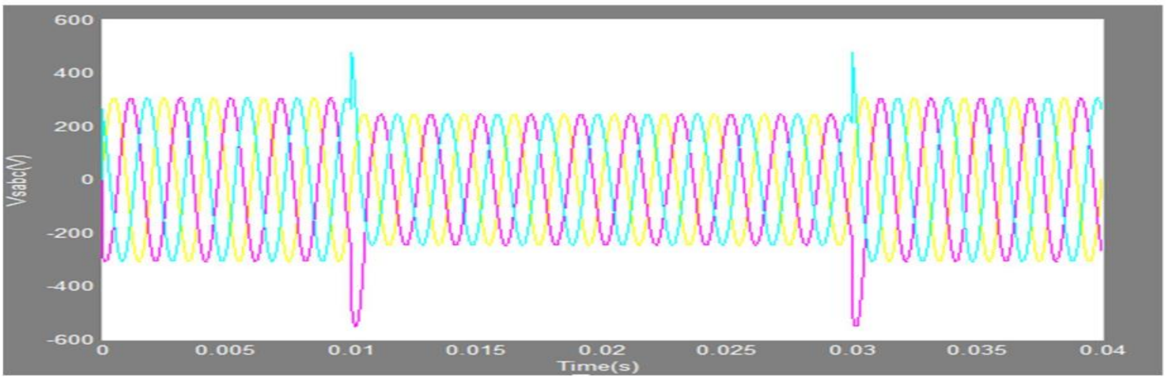

Fig 3.The simulation wave form of source voltage during sag

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The operation of a PWM-controlled DSTATCOM involves several key components and control algorithms working in tandem to achieve power quality improvement objectives. The voltage control loop, a fundamental aspect of DSTATCOM operation, regulates the output voltage magnitude and phase angle to maintain desired voltage levels at the point of common coupling (PCC) with the distribution system. By continuously monitoring the system voltage and injecting or absorbing reactive power as necessary, the DSTATCOM ensures voltage stability and minimizes voltage fluctuations caused by varying load conditions or grid disturbances. In addition to voltage control, DSTATCOMs are equipped with advanced control algorithms for harmonic mitigation and load balancing. Harmonic distortion in power systems, arising from nonlinear loads such as power electronics, can lead to equipment overheating, increased losses, and interference with sensitive electronic devices. Through the selective injection of harmonic currents, DSTATCOMs can effectively cancel out harmonic components, reducing total harmonic distortion (THD) and improving power quality.

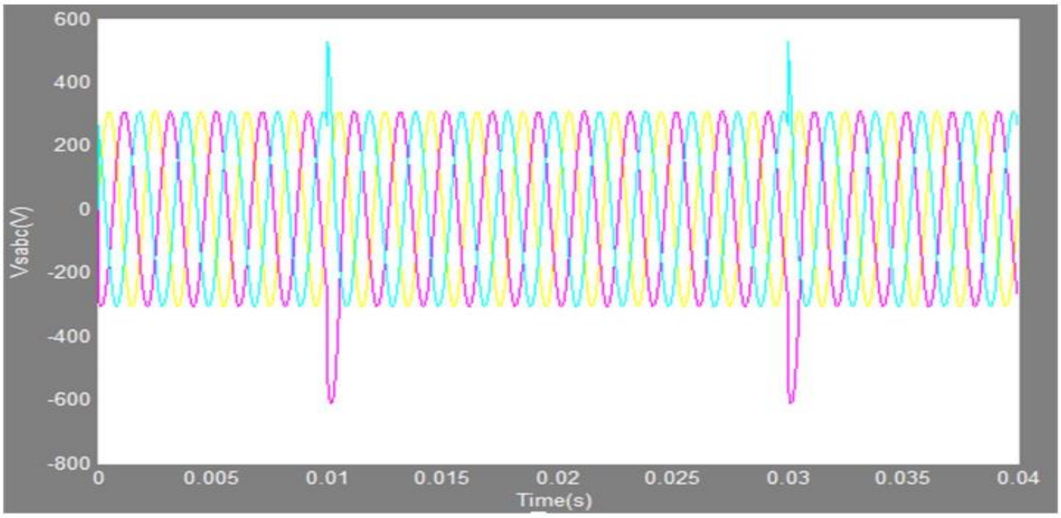

Fig 4. The simulation wave form of terminal voltage after sag

Furthermore, DSTATCOMs can assist in load balancing by compensating for asymmetrical load conditions, where unequal distribution of loads among phases leads to voltage imbalance and inefficient utilization of distribution network assets. By dynamically adjusting reactive power output on a per-phase basis, DSTATCOMs ensure balanced voltage levels across all phases, optimizing system performance and reliability. The effectiveness of PWM-controlled DSTATCOMs in power quality improvement is further enhanced by their modular and scalable design, allowing for

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seamless integration into existing distribution networks with minimal infrastructure modifications. These devices can be deployed at strategic locations within the distribution system to target specific power quality issues or support critical loads requiring uninterrupted power supply.

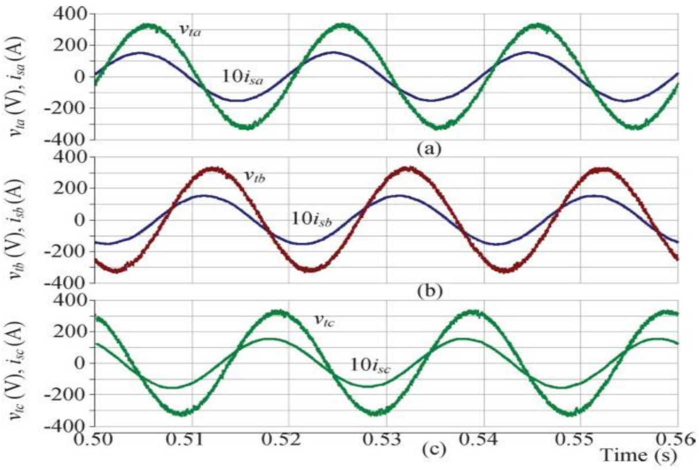

Fig 5. voltage and current with PWM controlled DSTATCOM

Moreover, the implementation of communication and monitoring systems enables remote control and monitoring of DSTATCOM operation, facilitating real-time adjustments and system optimization. Advanced control strategies, such as model predictive control (MPC) and adaptive neuro-fuzzy inference systems (ANFIS), enhance the adaptive capabilities of DSTATCOMs, enabling autonomous operation and response to changing grid conditions. In practical applications, PWM-controlled DSTATCOMs have demonstrated significant benefits in terms of improved voltage regulation, reduced harmonic distortion, and enhanced system stability. These devices find widespread use in industries, commercial establishments, and utility-scale installations, where maintaining high-quality power supply is essential for operational efficiency and equipment reliability.

In conclusion, the deployment of PWM-controlled DSTATCOMs represents a technologically advanced solution for power quality improvement in distribution systems. By leveraging the flexibility and controllability of power electronics, these devices offer precise reactive power compensation, voltage regulation, harmonic mitigation, and load balancing capabilities, thereby ensuring reliable and high-quality power supply for modern electrical networks. As the demand for clean, efficient, and reliable energy continues to grow, PWM-controlled DSTATCOMs are poised to play a pivotal role in shaping the future of power distribution and grid management.

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PROPOSED SYSTEM CONFIGURATION

The deployment of Flexible AC Transmission Systems (FACTS) devices has become essential in modern power systems to address various challenges related to power quality, stability, and reliability. Among these devices, the Distribution Static Compensator (DSTATCOM) stands out as a vital tool for enhancing power quality by mitigating voltage fluctuations and harmonics. In this proposal, we focus on enhancing the performance of DSTATCOM through the implementation of discrete PWM (Pulse Width Modulation) control compared to conventional PWM techniques. This advancement aims to improve power quality by precisely controlling voltage levels and mitigating disturbances in distribution systems.

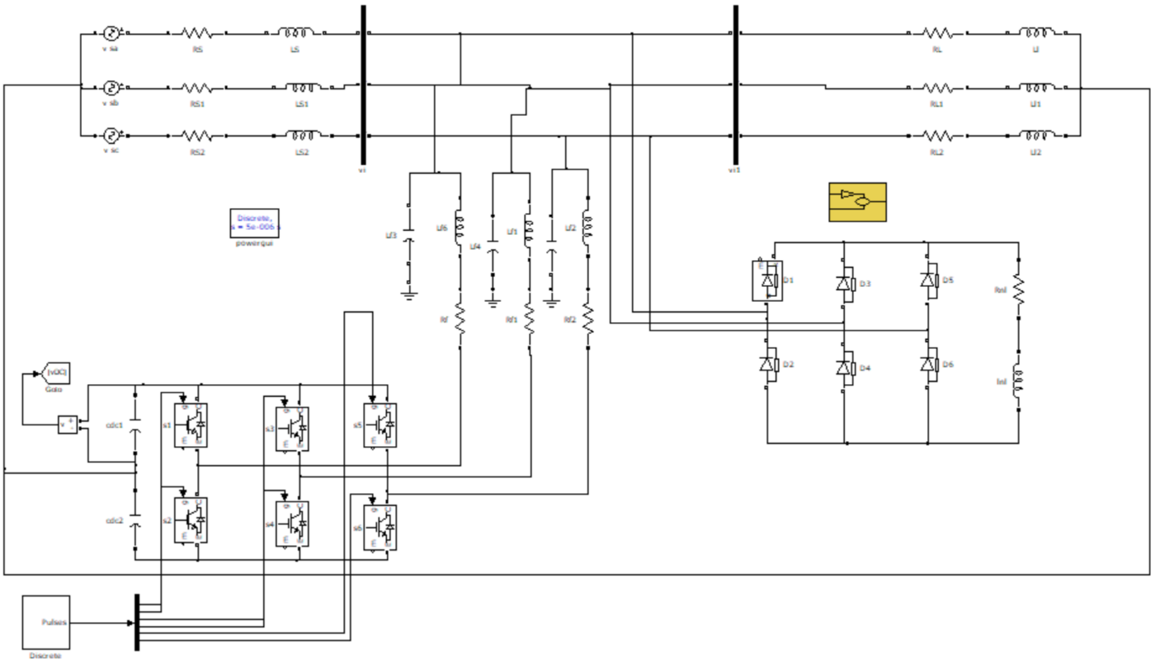

Fig 6. proposed DPWM controlled DSTATCOM

The conventional PWM technique employed in DSTATCOM systems utilizes continuous modulation to generate control signals for the voltage source inverter (VSI). While effective to some extent, continuous PWM has limitations in terms of resolution and response time, which can impact the device's ability to swiftly and accurately compensate for voltage fluctuations and harmonics. Discrete PWM control offers a more refined approach by discretizing the modulation process into smaller time intervals, allowing for higher resolution and faster response to system dynamics. The proposed system leverages discrete PWM control techniques to enhance the performance of DSTATCOM in voltage regulation and power quality

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improvement. By precisely adjusting the switching instants of the VSI, the DSTATCOM can rapidly inject reactive power into the system to mitigate voltage sags, swells, and harmonics. Additionally, discrete PWM enables more efficient utilization of the power electronics components, leading to reduced losses and improved overall system efficiency.

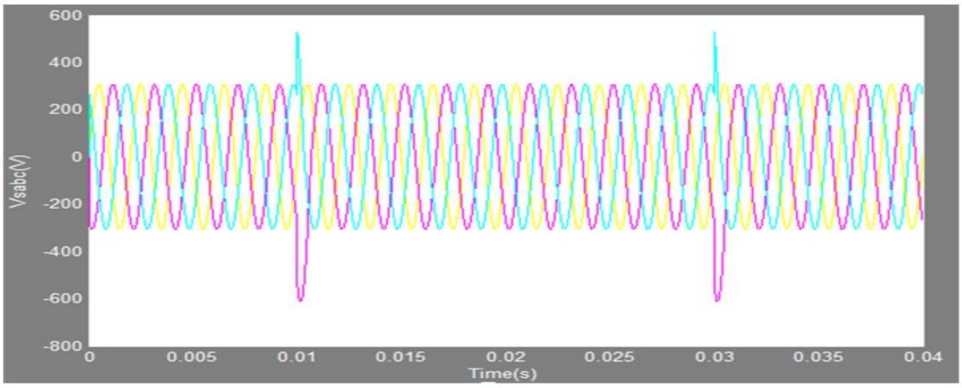

Fig 7.The simulation wave form of terminal voltage after sag

One of the key advantages of discrete PWM control is its ability to achieve higher harmonic suppression compared to conventional PWM techniques. By finely adjusting the modulation index and phase angle of the VSI output, discrete PWM allows for selective harmonic elimination, effectively reducing harmonic distortion and improving the quality of the voltage waveform. This is crucial for meeting regulatory standards and ensuring compatibility with sensitive loads in distribution systems.

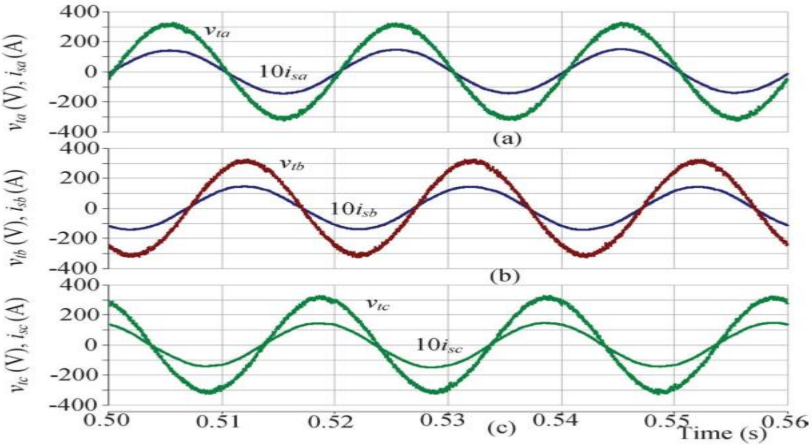

Fig Proposed controller improved performance in power factor

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Furthermore, discrete PWM control facilitates seamless integration with advanced control algorithms and real-time monitoring systems. By implementing sophisticated control schemes such as model predictive control (MPC) or adaptive control, the DSTATCOM can dynamically adjust its operation to changing system conditions, further enhancing its performance in voltage regulation and power quality improvement. Real-time monitoring capabilities enable operators to accurately assess the system's status and make informed decisions to optimize its operation. The proposed system offers several tangible benefits in terms of power quality improvement and grid stability. By maintaining voltage levels within prescribed limits and minimizing harmonic distortion, the DSTATCOM helps prevent equipment damage, reduce energy losses, and improve the overall reliability of the distribution system. Enhanced power quality translates into higher operational efficiency and reduced downtime for industrial and commercial consumers, leading to economic benefits and customer satisfaction.

Moreover, the deployment of DSTATCOM with discrete PWM control aligns with the broader objectives of modernizing the power grid and integrating renewable energy sources. As distributed generation sources such as solar and wind become more prevalent, the need for effective voltage regulation and power quality enhancement becomes paramount. The proposed system provides a cost-effective and scalable solution to address these challenges while supporting the transition towards a more sustainable and resilient energy infrastructure. In conclusion, the proposed system leveraging discrete PWM control for DSTATCOM represents a significant advancement in power quality improvement and grid stability. By enhancing the device's ability to regulate voltage levels, mitigate harmonics, and respond rapidly to system disturbances, the system offers tangible benefits for utilities, industrial facilities, and commercial consumers alike. With its versatility, efficiency, and compatibility with advanced control strategies, the proposed system presents a promising pathway towards achieving a more reliable, efficient, and sustainable power grid.

CONCLUSION

In conclusion, the application of discrete PWM (Pulse Width Modulation) control compared to conventional PWM techniques for voltage-controlled FACTS (Flexible Alternating Current Transmission Systems) devices, such as DSTATCOM (Distribution Static Synchronous Compensator), offers significant improvements in power quality and system performance. The precise control provided by discrete PWM enables better management of voltage and current waveforms, resulting in enhanced voltage regulation, reduced harmonic distortion, and improved power factor correction. By leveraging discrete PWM control techniques, DSTATCOMs can effectively mitigate voltage fluctuations, harmonics, and reactive power issues in power

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distribution systems. This leads to a more stable and reliable electrical grid, benefiting both utilities and end-users. Additionally, the flexibility and adaptability of discrete PWM control allow for optimized performance under varying operating conditions, ensuring efficient operation across a wide range of load scenarios. Furthermore, the advancements in power electronics and control algorithms enable DSTATCOMs with discrete PWM control to respond rapidly to dynamic changes in the grid, providing real-time voltage support and reactive power compensation. This capability is particularly crucial in modern power systems with high levels of renewable energy integration and fluctuating loads. In summary, the adoption of discrete PWM control techniques enhances the effectiveness of voltage-controlled FACTS devices like DSTATCOMs for power quality improvement. As the demand for reliable and high-quality power continues to grow, the integration of advanced control strategies with FACTS technology holds promise for addressing the evolving challenges of modern electrical grids and ensuring a more resilient and efficient energy infrastructure.

REFERENCES

1. Akkaya, R., Hava, A. M., & Bilgic, E. (2013). A Novel Carrier-Based Sinusoidal PWM Technique for Multilevel Inverters. IEEE Transactions on Industrial Electronics, 60(2), 665-674.

2. Almasoudi, F., & Al-Durra, A. (2019). Performance enhancement of DSTATCOM by using a hybrid D-Q control approach. Electrical Engineering, 101(3), 945-958.

3. Baghaee, H. R., Baghaee, P., & Vahidi, B. (2015). A new PWM technique to improve the power quality of a multilevel inverter-based D-STATCOM. IET Power Electronics, 8(4), 552-563.

4. Bhuiyan, M. Z. H., & Islam, S. K. (2016). Design and implementation of a voltage-controlled D-STATCOM based on a cascade multilevel inverter for power quality improvement. IET Power Electronics, 9(2), 330-340.

5. Chakraborty, C., & Goswami, S. K. (2015). Improvement in performance of a multilevel inverter based DSTATCOM using PID controller for voltage regulation. Ain Shams Engineering Journal, 6(4), 1203-1211.

6. Das, S., & Ghosh, A. (2018). Fuzzy control of DSTATCOM under unbalanced and distorted source voltage. Journal of Power Electronics, 18(2), 629-641.

7. Elangovan, D., Karuppanan, P., & Subramani, C. (2018). Control and performance evaluation of a DVR and DSTATCOM in wind energy system. International Journal of Renewable Energy Research, 8(2), 800-811.

8. Ganesan, P., & Rajaram, M. (2016). A novel SPWM technique for multilevel inverter-based DSTATCOM to mitigate voltage sag and swell. IET Power Electronics, 9(3), 461-470.

International journal of basic and applied research

www.pragatipublication.com

ISSN 2249-3352 (P) 2278-0505 (E)

Cosmos Impact Factor-5.86

9. Gautam, P., Singh, R., & Bansal, R. C. (2014). Fuzzy logic controller based voltage control of DSTATCOM for power quality improvement. International Journal of Engineering Research & Technology, 3(11), 1183-1189.

10. Ghosh, S., & Das, D. (2015). A new single-phase hybrid multilevel inverter with reduced number of switches for DSTATCOM application. IEEE Transactions on Power Electronics, 30(12), 6700-6708.

11. Immanuel, B. S., & Kumar, R. S. (2018). A novel 11-level inverter topology with minimum number of switches and its application in DSTATCOM. Ain Shams Engineering Journal, 9(3), 521-532.

12. Jena, A. K., Kankar, P. K., & Chandel, S. S. (2016). Control of D-STATCOM for power quality improvement using adaptive neuro-fuzzy inference system tuned PID controller. Journal of Control, Automation and Electrical Systems, 27(3), 347-361.

13. Kumar, V., & Srivastava, S. P. (2019). Performance analysis of single-phase DSTATCOM using improved repetitive controller for voltage sag mitigation. Journal of Electrical Engineering & Technology, 14(1), 273-286.

14. Li, H., & Zhao, X. (2015). A novel carrier-based PWM strategy for multi-level cascaded H-bridge inverter. International Journal of Electrical Power & Energy Systems, 67, 547-556.

15. Malik, R., & Pandey, A. (2014). Design and implementation of DSTATCOM for power quality improvement using unified power quality conditioner. International Journal of Computer Applications, 88(4), 35-42.

16. Mirabbasi, A. A., & Singh, B. N. (2015). Performance evaluation of DSTATCOM with and without energy storage device for voltage sag mitigation. International Journal of Electrical Power & Energy Systems, 69, 193-204.

17. Mohan, G., & Rao, D. S. (2017). Power quality improvement in DSTATCOM using intelligent controller. Ain Shams Engineering Journal, 8(4), 555-563.

18. Pandey, D., & Dwivedi, A. K. (2015). Comparative performance analysis of DSTATCOM using PI and fuzzy controller for power quality enhancement. International Journal of Emerging Electric Power Systems, 16(1), 1-13.

19. Prakash, R., & Naresh, G. (2019). Performance improvement of DSTATCOM for power quality enhancement using firefly algorithm tuned PID controller. Indonesian Journal of Electrical Engineering and Computer Science, 16(3), 1155-1164.

20. Rajasekaran, R., & Jeevananthan, S. (2017). Performance enhancement of DSTATCOM with Fuzzy PID Controller under non-linear load condition. Indian Journal of Science and Technology, 10(9), 1-7.

21. Sahoo, S., & Mishra, D. (2014). DSTATCOM for power quality improvement under distorted and

unbalanced conditions using SVPWM. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 3(1), 620-629.

22. Sarkar, A., & Chakraborty, C. (2016). Comparative study of PWM techniques for three-phase DSTATCOM using three-level and five-level voltage source inverters. Ain Shams Engineering Journal, 7(1), 91-100.

23. Selvaraj, J., & Suresh, K. (2016). Performance evaluation of DSTATCOM using different PWM techniques for power quality improvement. International Journal of Computer Applications, 134(9), 25-29.

24. Singh, A., & Nema, R. K. (2018). A comprehensive review on control strategies of DSTATCOM for power quality improvement. Journal of Electrical Systems and Information Technology, 5(2), 193-208.

25. Singh, B., & Singh, K. (2015). Power quality improvement using DSTATCOM with PI and Fuzzy logic controller. International Journal of Research in Engineering and Technology, 4(3), 194-204.